# Engineering News-Record

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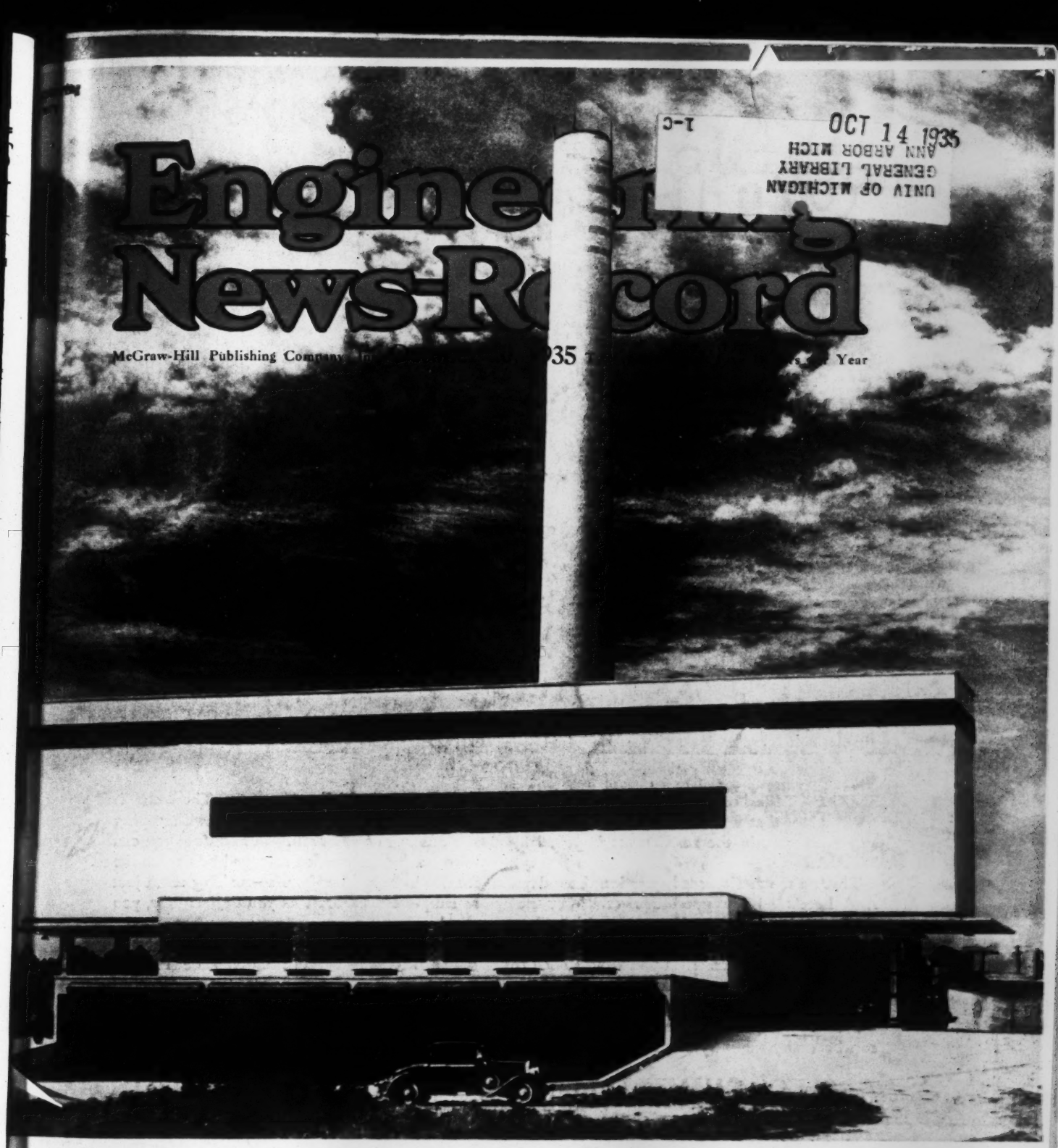

Modern and modernistic, this new incinerator typifies public works in Shreveport, La.

## IN THIS ISSUE:

The New Coney Island Sewage Plant
Developing Well Water for Tacoma
Grouting a Leaking Earth Dam
Water Tunnel Driving at Pasadena
Sewage Plant Developments, by Samuel A. Greeley
International Cleansing Congress, by Harrison P. Eddy, Jr.

# 1 way to solve YOUR WORK RELIEF PROBLEM

WHAT kind of a work relief project can I plan, that will be *really worthwhile* and still come within the restrictions imposed by W. P. A.?

That's a much-discussed question these days. And here's a very good answer. Why not replace some of those dangerous old bridges in your locality, with Armco Multi Plate arches? Probably the only material you would need to buy would be a few corrugated iron plates and a small amount of cement.

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# Does "*Labor Make Wealth*"?

LAST week this page cited the Boulder Dam to indicate how useful public works, planned and executed in normal fashion, may contribute to industrial recovery. Meanwhile the President, in his address of dedication, has made the same point. He extols the project as having provided during the depression years work for many thousands who "were enabled to earn a livelihood *through manufacture of materials and machinery.*" But with that singular inability to reconcile his deeds and his words, the President, on the eve of that utterance, approved a program designed explicitly to curtail federal assistance to useful public construction in favor of employment that would involve a minimum use of materials and machinery.

Another aspect of his curious inconsistency is revealed elsewhere in the President's address. In one place he says, "we give actual work to the unemployed and at the same time we add to the wealth and assets of the nation." Here the President defines a sound objective. But just two sentences farther along he ignores it to declare, without qualification, that "labor makes wealth." Is it possible that right here we find the key to so much that has been bewildering in the administration's public works policy? Has someone sold the President the amazing notion that in itself "labor makes wealth." On no other presumption can we explain the repudiation of his public works policy, so soundly formulated in January, in favor of a program that contemplates only more jobs, regardless of results.

OF course the notion that "labor makes wealth" is utterly haywire. We can be certain only that all labor *consumes* wealth, as embodied in the food, clothing, shelter and other goods that are consumed by those who labor. But labor *creates* wealth only when it is expended with vision, wisdom and efficiency on a purpose of proportionate utility and value to the community. If, in the long run, this labor really is to "add to the wealth and assets of the nation," the wealth that it creates must exceed in value the wealth that it surely consumes in the process. If this condition does not prevail, labor will most effectively *destroy* wealth by just the amount its consumption exceeds its creation.

To be sure, all this is aside from the social desirability of protecting men and women from idleness and despondency. That is another matter. If, because of maladjustment of normal industrial processes, the community feels that it can wisely devote some of its producers' income to conserving its human resources, it may do so. And if it believes that a program of made-work is preferable to an outright dole, it may well undertake it *as a relief measure.* But let us have done with all this twaddle about such a procedure necessarily adding to the "wealth and assets of the nation," on the absurd assumption that "labor makes wealth." And let us stop this business of applying welfare principles to the conduct of useful public construction which, handled by normal methods, can add to the wealth and assets of the nation.

THE truth is that the direction and use of labor so that it actually will create wealth has been the most exacting task that has absorbed the genius of man; and as time goes on, its mastery depends more and more on the coordination of many factors. The President cited a few of them: "the accumulated engineering knowledge and experience of centuries * * * the genius of designers * * * the energy, resourcefulness and zeal of builders * * * the brain and brawn of workers." To these he might have added the social and economic wisdom of statesmen, the soundness and integrity of finance and the competence of management. And most of all, *the driving power of incentive,* which flows from the producer's confidence that he will be permitted to enjoy the fruits of his productivity. But that is another story all by itself.

Certain it is that labor does not make wealth by virtue of Presidential assertion, congressional enactment, executive order or the aspirations of socially-minded welfare workers. And most certainly it cannot make wealth if in its use we scorn the normal industrial channels and agencies that have survived through the generations only because they have been successful in converting labor into wealth. The President *says* this over and over again; why can he not *practice* it?

Willard Chevalier

ENGINEERING NEWS-RECORD

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*Table of Contents—See Page 35*

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## CONTENTS FOR OCTOBER 10, 1935

VOLUME 115 NUMBER 15 COPYRIGHT 1935

Treating Coney Island's Sewage ..... 489

Casting 72-In. Concrete Pipe in 24-Ft. Lengths 493

Report on Treatment for San Francisco Sewage 495

Supreme Court Reviews Valuation Procedure 496

Grouting Checks Leakage in Earthfill Dam.... 499
BY E. M. WILBUR

Recent Sewage-Plant Developments..... 501
BY SAMUEL A. GREELEY

Nationwide Control of Water Pollution..... 505

International Congress on Public Cleansing.. 507
BY HARRISON P. EDDY, JR.

TVA Adopts Labor-Relations Policy..... 511

High-Speed Tunnel Driving at Pasadena..... 513

Developing Well-Water Sources at Tacoma.. 514

Editorials ..... 516

Current News ..... 518

Unit Prices ..... 523

## In the News:

ENGINEERING SUPERVISION of WPA projects was placed in the hands of the Army Engineers this week. PWA discarded the requirement that 90 per cent of all labor employed must come from relief rolls. These are the outstanding public-works developments of the week.

PWA WILL OPERATE the 37 housing developments to be built with the $100,000,000 fund allotted to it. Housing managers are being trained, according to latest announced plans.

The A. F. of L. meeting in Atlantic City is considering a committee report recommending the banning from membership of organizations or persons "espousing communism or advocating violent overthrow" of American institutions.

RETURNS FROM BANKS show no increase in real estate loans under the new Banking Act, which liberalized this provision in the law. Natural slowness in changing their loan policies on the part of bankers and lack of knowledge as to the change on the part of builders are said to be the causes.

SUBURBAN HOUSING by the Resettlement Administration will be built at Cincinnati, Oakland, St. Louis, Bound Brook, N. J., and Beltsville, Md.

## In This Issue:

ONE OF THE MOST MODERN SEWAGE PLANTS in the country will begin treating the sewage of the Coney Island section of New York City in December. Screenings will be ground and returned to the wet well, chemicals will aid precipitation during the summer months, vacuum filtration will produce a sludge cake suitable for fill, and sludge gas collected in holders over digestion tanks will operate 300-hp. engines for electric current generation and will be used for heating requirements. The layout of the plant units gives a distinctive, modern appearance.

THE EXCEPTIONAL MODERNITY of the Coney Island plant as well as the remarkable development of sewage-treatment facilities in general is further emphasized by an article prepared for this issue by Samuel A. Greeley of Chicago. Anyone who has not closely followed developments will be amazed by the changes of the past five years.

CASTING CONCRETE PIPE 6 ft. in diameter and 24 ft. long is an unusual if not an unprecedented operation that resulted from the requirements for the subaqueous outfall of the Coney Island sewage plant. The casting procedure is outlined.

THE WATER POLLUTION REPORT made to the National Resources Committee, as reviewed briefly in our news pages last week, is presented in more detail in this issue.

TO CONCLUDE the sewage-treatment element of this issue, the recommendations of a special consulting board relative to San Francisco sewage are presented. Because of the large dilution afforded by surrounding waters, partial treatment only is advised.

VALUATION PROCEDURE, particularly with respect to the use of price indexes, was reviewed by the U. S. Supreme Court in the recent Chesapeake & Potomac Telephone Co. case. The decision is abstracted in considerable detail as providing new basic information in a field of major interest to many engineers.

REPAIR OF AN EARTHFILL DAM by cement grouting was successfully carried out by the Port Jervis, N. Y., water department. The procedure is outlined by the engineer in charge.

GARBAGE AND REFUSE COLLECTION and street cleaning were the principal items on the program of the Second International Congress for Public Cleansing held in Germany in August. Harrison P. Eddy, Jr., president, American Society of Municipal Engineers, and one of the two United States delegates, reports the meeting for *Engineering News-Record* in this issue.

TVA, LARGEST EMPLOYER of construction labor, has adopted a labor-relations policy full of significance for the industry. The complete statement of policy is published that it may be widely studied.

TACOMA, served with a gravity water supply, has instituted a plan of driving deep large-capacity wells to meet increasing industrial demand for water. The plan and driving procedure are set forth in a brief article.

THE COLORADO RIVER AQUEDUCT terminates in a 150-mile distribution system serving the various cities of the Metropolitan water district, among them Pasadena, where work is under way on a 12,000-ft. tunnel. Unusually rapid driving of the 13-ft. bore is described in this issue.

## Coming Articles:

PREVENTION OF FLOODS in the industrial section of East St. Louis, Ill., is being accomplished by placing the lower 4-mile section of meandering Cahokia Creek in a 2-mile outfall composed of both open-channel and three-box conduit with a 2,000-sec.-ft. capacty. At the outlet into the Mississippi River, a diesel-engine pumping station will be installed, to lift floodwaters over the levee during times of high water. (See photo page 504, this issue.) Next week this 2½-million-dollar flood-control scheme will be described in both its design and construction phases.

# SCULPTURED *in* STUCCO

Durable, economical Atlas White stucco marked off to resemble stone is the finish specified by Architects Grant & Bruner for this million-dollar Helms Bakeries plant. Ed Westberg was the plastering contractor. Watkins Company was the cast stone manufacturer. (All of Los Angeles.)

Before preliminary plans for this new million-dollar bakery were started, two requirements were set by the owner. First requirement: quality materials only. Second requirement: absolute minimum cost.

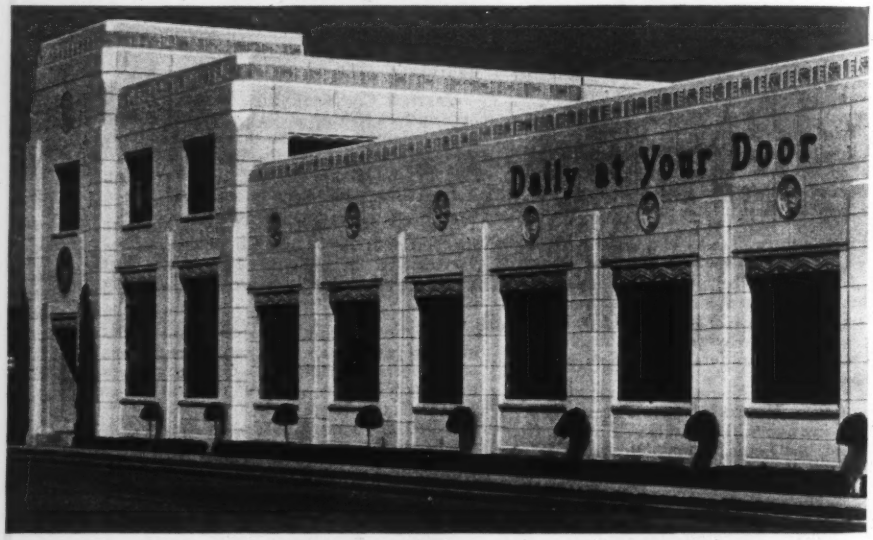
The architect's answer to those specifications is of dollars-and-cents interest to every contractor and engineer responsible for satisfactory completion of new construction and remodeling work. He said "the finish will be stucco and cast stone. Atlas White portland cement specified for both."

You can see the result. The exterior finish is Atlas White stucco, in smooth finish, marked off to resemble stone. Ornamentation is cast stone, also made with Atlas White. Both of the owner's requirements were met in full—not simply on the basis of acceptance, but to his enthusiastic approval.

For "Modernizing Main Street" and for new buildings, Atlas White stucco (*preferably factory-prepared*) is a finish that combines durability and excellent appearance with *proved* economy. It's worth investigating. May we send you the details? Write Universal Atlas Cement Co. (*United States Steel Corporation Subsidiary*), 208 South LaSalle Street, Chicago.

21

Stucco made with Atlas White can be applied in *any finish* suited to the architectural design, and in *any color*—from pure white like that shown here to bright reds and greens and yellows. For remodeling work particularly, as well as for new construction, these two qualities alone place Atlas White stucco at the top of the list of preferred finishes.




# STUCCO *made with* ATLAS WHITE
## PORTLAND CEMENT

ENGINEERING NEWS-RECORD

October 10, 1935

Arnold Air Photo

FIG. 1—Mass grouping of the several plant units is a feature of new Coney Island sewage plant. Completed sedimentation tanks on the left are clarifying 18 m.g.d. of sewage while construction is being pushed forward on other units in the plant.

# Treating Coney Island's Sewage

**Plain sedimentation augmented by chemical precipitation and chlorination during summer months features 35-m.g.d. sludge-gas-operated plant nearing completion in New York City—Effluent discharged 1½ miles from shore**

THE FIRST STEP toward abatement of New York harbor pollution, with health protection for the millions of bathers using the Coney Island and adjoining beaches, is signified by rapid construction of the new Coney Island sewage-treatment plant, which will be in full operation shortly after the first of the year. As the second unit to be started among the 38 proposed new installations for treating the waste from the five boroughs of New York City, it will rank as the first new treatment plant to be placed in operation for carrying out the ambitious and long-delayed program to curtail the discharge of raw sewage into Greater New York waters. The Wards Island activated sludge plant, initial project of the Department of Sanitation, is partly finished but cannot be placed in operation until intercepting sewer tunnels and grit chambers have been constructed; the grit chamber contract was let Sept. 8, and bids for the interceptors have been received.

Located on Shell Bank Creek near the world-famous seashore resort in the Borough of Brooklyn, the new Coney Island plant has been designed to treat 35 m.g.d. of sewage from a population of 300,000 in a contributory area of 1,700 acres. The present population is 172,000. Plans have been prepared with a view toward future extension which will increase plant capacity for treatment of 140 m.g.d. from the estimated 1960 population of 1,200,000 persons in a tributary area of 11,450 acres.

FIG. 2—LOCATION and drainage area of New York's Coney Island plant. The relative position of the Wards Island plant is also shown.

The treatment process includes coarse screening followed by plain sedimentation and supplemented by chemical precipitation and chlorination for additional purification during the four summer months. Separate digestion of sludge will be utilized to provide gas for the operation of engine-driven generators to supply power for plant uses, and the digested sludge will be mechanically dewatered by means of vacuum filtration. Filter cake is to be used as top dressing at the plant site and by the Park Department as fill for land reclamation.

### Selection of treatment

The large dilution factor afforded by the proximity of the outfall to ocean tidal currents obviated the necessity for a considerable reduction of biochemical oxygen demand, and only during the bathing season was it deemed essential to provide a high degree of clarification and bacterial purity. Restrictions of site (because of streets which could not be closed), the necessity for immediate operation and the degree of purification required were the criteria by which the compactness and lower cost of the chemical plant were favored over the

alternate activated-sludge method of treatment.

The desirability of sludge digestion in conjunction with the purification process was advocated for several reasons: utilization of the gases of decomposition for the production of plant power offered substantial operating economies, particularly in view of the high electric rates in this locality; barging the raw sludge to sea was not feasible because only a comparatively small amount will be produced in two days, which is the maximum time it shoud be held, and this would make for small barge loads and relatively high towing charges; and finally, digested sludge has less bulk than the raw material and can easily be dewatered for use as unoffensive fill material.

Outstanding features of the project in addition to a compact and well designed plant are the concrete outfall sewer terminating in a gate chamber and diffusion system, the use of floating gasholder covers over the eight digestion tanks and the flexible chemical handling and chlorinating equipment. Particularly noteworthy is the architectural conception of the plant layout, which has been designed to present a harmonious mass grouping of the individual units.

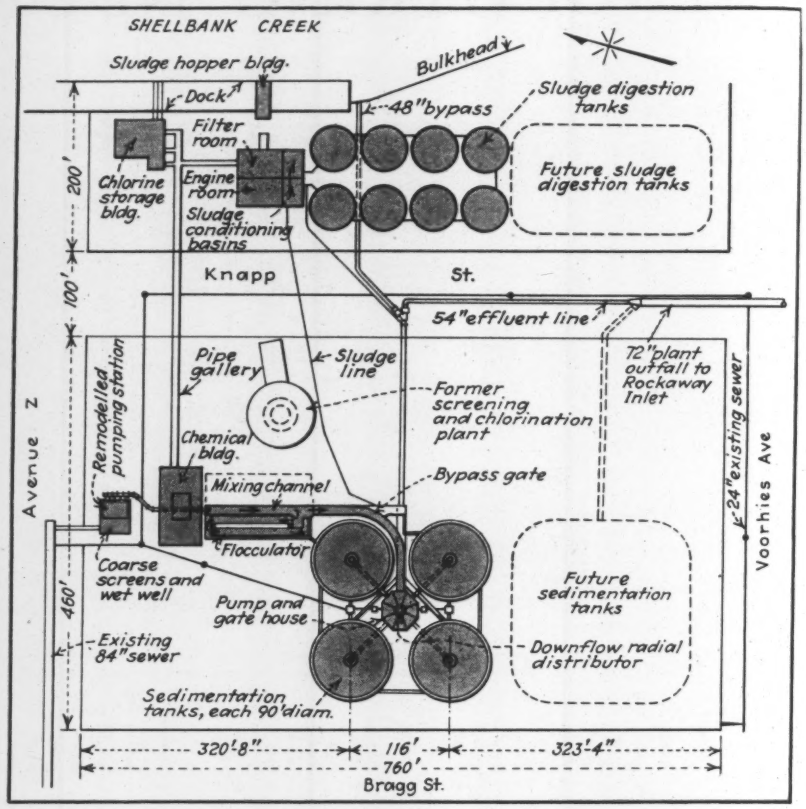



FIG. 3—LAYOUT of Coney Island plant units adapts the present facilities and a future 35-m.g.d. extension to the site without disturbing existing streets.

## Rapid construction progress

Construction was started on March 17, 1935, and completion of all structural work and the installation of major equipment is anticipated by December. On July 1, sufficient progress had been made so that the present sewage flow of 18 m.g.d. could be treated with plain sedimentation and chlorination. The clarified, sterile effluent from this treatment was emptied at the start into Shell Bank Creek through a 48-in. bypass outfall that has been provided for temporary plant emergencies. The effluent is now being discharged into Rockaway Inlet through the 72-in. outfall. Raw sludge, averaging 135 tons per day (solids content 5 per cent), is temporarily being barged to sea.

## Sewage raised to plant flow-line

Raw sewage enters the treatment works through an existing 84-in. trunk sewer to a pumping station, already on the plant site, which formerly lifted the flow for discharge into Shell Bank Creek. This lift station has been remodeled and enlarged to accommodate six vertical motor-driven pumps with a total capacity of 58 m.g.d., which raise the sewage approximately 40 ft. to the plant flow-line after it has passed through hand-cleaned coarse screens. The existing equipment comprised three 10-in. centrifugal pumps, and to this have been added two 16-in. units driven by 100-hp. motors, and one 20-in. pump with a 200-hp. motor. The average power load when pumping 35 m.g.d. will be 300 b.hp. There are no grit chambers, and screenings will be ground to a pulp and discharged into the wet well. From the pumping station the sewage is carried in a 48-in. pipe line which passes through the substructure of the chemical building where iron and lime solutions will be added in quantities automatically governed by a differential pressure mechanism connected to the 48x39-in. venturi tube installed in the pipe line ahead of the chemical feed. Prechlorination may also be carried out at this point. After the application of chemicals, estimated to be 500 lb. hydrated lime (60 p.p.m.) and 300 lb. of ferric sulphate (36 p.p.m.) per million gallons, the sewage rises upward 16½ ft. to enter a mixing channel (Fig. 4) 6x8-ft. in cross-section and 116 ft. long in which there are seven vertical around-the-end baffles alternately extending to the center of the channel. Following this are two parallel flocculating channels, of the same length but with a water cross-section of 13x13 ft. in which the flowing sewage will travel a total distance of 231.5 ft. at a linear velocity of 0.34 ft. per second. The average detention time is 11.4 minutes. Ten metal paddles are attached in progressive phases on a 4-in. steel drive-shaft supported along the longitudinal center-line of each channel. The paddles rotate in a 12-ft. circle at right angles to the direction of flow, and this slow sweeping action will aid in building a heavier floc.

## Sedimentation tank details

Four sedimentation tanks are grouped around an octagonal-shaped pump and gatehouse structure in which are centralized the valve controls to each tank, pumps for removing sludge to the digestion unit and a central distribution well (Fig. 5). This latter device is of special design and is expected to solve the problem of distributing an equal load of solids to each tank while maintaining an equal quantity of flow. The principle of operation is simple. Sewage enters at the top of a 10½-ft. circular well, located in the center of the pumphouse, and as it flows downward for a distance of 18 ft. it becomes a thoroughly agitated and homogeneous mixture. In this condition it is conveyed to the settling tanks through four 30-in. cast iron pipes extending radially and spaced equidistant around the bottom circumference of the well as shown in Fig. 5. Since these outlet pipes are of the same size and length and symmetrically located, it follows that with the tank effluent weirs set at a uniform elevation, they will supply an equal flow of similar solids composition to each unit.

The settling tanks provide a 2-hr. detention period and are 90 ft. in diameter and 15 ft. in depth, with a capacity

FIG. 4—MIXING CHANNEL baffles promote thorough chemical distribution before the sewage enters low-velocity flocculating channels equipped with rotating paddles to aid floc formation.

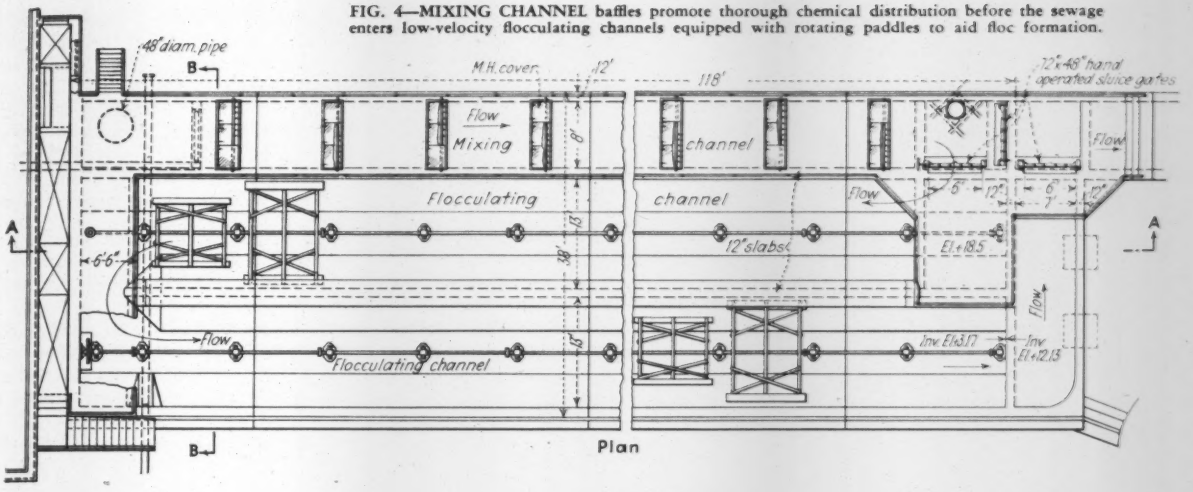
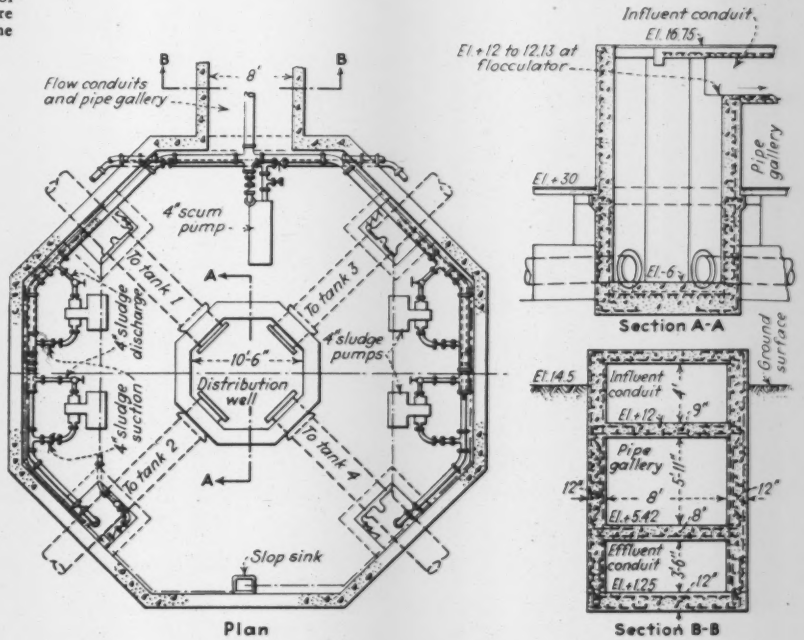



FIG. 5—SLUDGE PUMPING and tank control equipment (right) are housed in the structure around the central distribution well from which the influent passes to the sedimentation tanks.

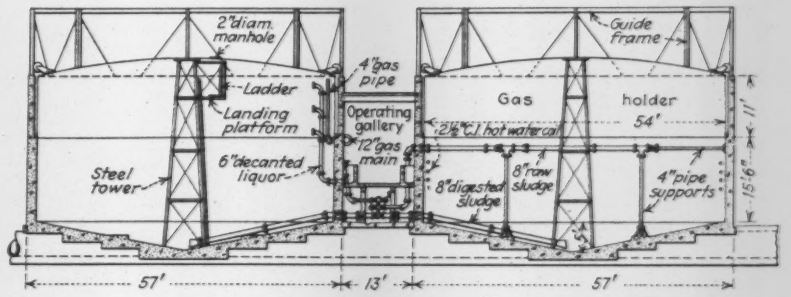



of 720,000 gal. each. Incoming sewage enters a hollow column in the center of the tank where it is diffused upward and outward at a greatly reduced velocity. Radial flow takes place in the direction of a peripheral outlet to which is attached a continuous copper-alloy weir. This weir plate is slotted with $\frac{3}{8}$-in. openings having a vertical height of 4 in. and cut with the sharp edge (no clog feature) characteristic of the fine-screens used in treatment plants.

A scum-collector blade is attached to the rotating sludge collector so that it will continuously skim the liquid surface. The floating material, estimated to vary from 500 to 2,000 gal. per day for each tank, will be periodically moved to a scum well by manual operation and from there pumped through the sludge line to the digestion tanks.

The influent and effluent channels are carried in a rectagular concrete box 15 ft. high and 8 ft. wide divided horizontally into three conduits. The top conduit conveys the influent to the central distribution well. The bottom conduit is the effluent channel, and the middle compartment serves as a pipe gallery for the sludge line, chlorine pipes and electrical wires (Fig. 5). Positive-displacement sludge pumps of 100-g.p.m. ca-

FIG. 6—GAS HOLDERS covering the sludge-digestion tanks. A central operating gallery gives easy access to all piping.



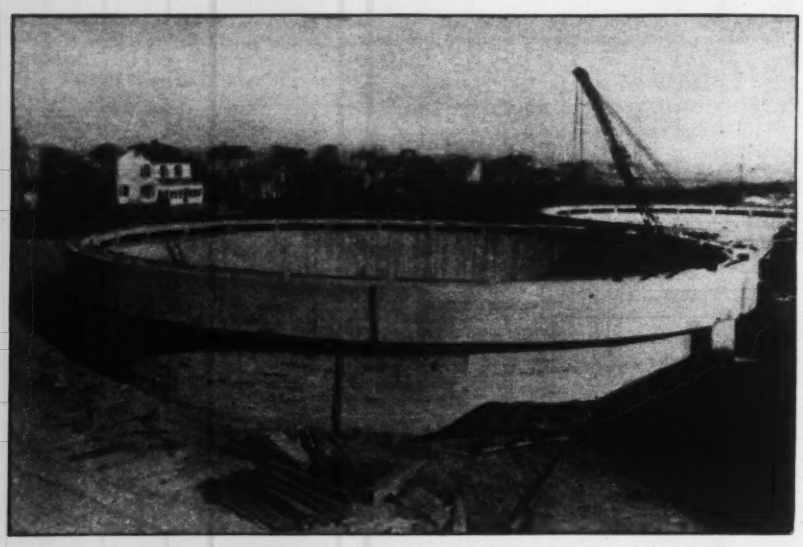


FIG. 7—CIRCULAR WEIR and channel around the sedimentation tanks provides for peripheral overflow of the effluent.

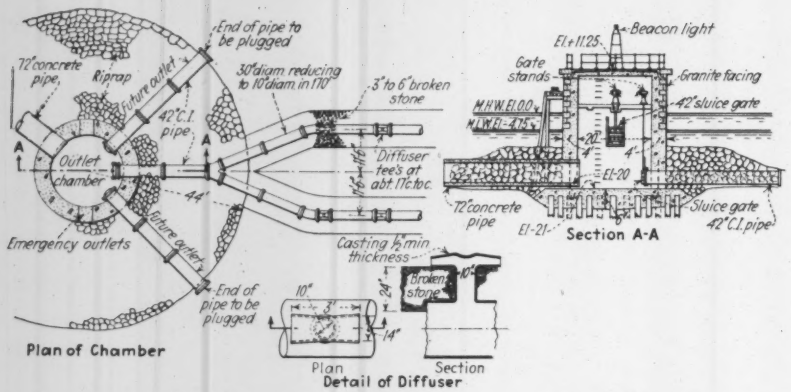



FIG. 8—SUBMERGED distribution chamber of outfall. T-heads along the outlet pipe assure thorough diffusion of the effluent.

capacity for each settling unit are housed in the central structure between the tanks and are connected to a 10-in. cast iron sludge line leading to the digestion-tank distribution chamber. Provision has been made for returning sludge to the mixing channel if such recirculation shows any economy in the use of chemicals. Operated as a plain sedimentation plant, it is expected that 2,500 gal. of sludge (95 per cent moisture) will be produced per million gallons, based upon 60 per cent removal of solids. When using chemical precipitation this will be increased to about 4,000 gal. of sludge, based upon 85 per cent removal.

## Sludge digestion and filtration

Eight concrete sludge digestion tanks, each 54.5 ft. in diameter and 28 ft. average depth, surmounted by gasholders, are located adjacent to the dock on Shell Bank Creek. Hot water pipes around the inside circumference of the tanks will maintain the contents at a temperature of 80 deg. F. Design calculations have been predicated upon an allowance of 1.6 cu.ft. of storage capacity per capita from which a yield of 0.7 cu.ft. of gas per day is expected; each tank has a volume of 59,740 cu.ft. of sludge and the attached gasholder has a capacity of 25,000 cu.ft. of gas. (Fig. 6 shows the details of design.)

Vacuum filtration of digested sludge is to be used in this plant, and the resulting filter cake will be conveyed to storage bins of 1,500-cu.ft. capacity for distribution either to trucks or barges. The filtrate will be returned to the wet well of the plant. Ulimate disposal of the dry sludge cake will provide fill for the future plant site and the projected Marine Park development near by; the Park Department is also expected to use considerable quantities for top-soil conditioning and enrichment.

Approximately 33 per cent reduction in solids will take place in the digestion process, and the digested sludge will be further conditioned by the addition of up to 6 per cent of ferric sulphate or 13 per cent of hydrated lime (based on the dry solids content) or a suitable combination of the two. Approximtaely ten minutes of mixing in the conditioning tank will be given to the sludge before it is applied to the filter. The single filter now installed, 11 ft. 6 in. in diam. and 16 ft. long, has an area of 570 sq.ft. With a feed of 100 g.p.m. (95 per cent moisture sludge) the yield will be 2,850 lb. of 70-75 per cent moisture-content filter cake per hour.

## Power plant

In the same building housing the vacuum filter and sludge-conditioning tank is placed the power plant composed of three gas-engine-driven electric generators with switchboards. Each generating unit consists of a 300-hp. 5-cylinder gas engine directly connected to a 200-kw. a.c. generator and exciter. A waste heat exchanger is interposed in the exhaust line from each gas engine for the purpose of recovering heat from the exhaust gases and transmitting it to the engine jacket water, which is then circulated as a heating medium through the heating coils of the digestion tanks and the hot water heating system of the plant buildings. Power requirements include six pumps (58-m.g. total capacity) utilizing 625 hp. and 50 motors totalling 260 hp. for operating the mechanical equipment. The average power load for pumping 35 m.g.d. will be 300 hp., and for treatment of the same amount of sewage an additional 100 hp. will be required.

In treating the wastes from the present population equivalent of 170,000 persons, the flow will be 20 m.g.d., requiring a power output of 240 hp. One gas engine, using 3,300,000 b.t.u. of fuel per hour, developing a rated capacity of 300 hp., will be operated. Sewage gas from the digestors, totalling 142,000 cu.ft. per day (based upon 0.715 cu.ft. per capita) with an average heat value of 650 b.t.u. per cu.ft., will be ample to operate the engine and leave a surplus for heating the digestion tanks and building. Should actual gas production be less than this figure the deficit will be supplied by gas purchased from the local utility company.

## Chemical handling

Dry chemicals will be delivered in barge-load lots or by truck to the chemical building in the plant where storage facilities have been provided for more than 175 tons of hydrated lime and 100 tons of ferric sulphate, sufficient for a 15-day period of operation. A pneumatic vacuum system has been installed to bring these materials 500 ft. to a 10-in. delivery pipe that enters the chemical building through an exhauster in the roof tower. Storage bins in the basement of the building are connected by conveyors and automatic weighing machines to charging hoppers above the dry-feed machines which discharge into

solution chambers. Automatic proportional feed on these machines is governed by differential pressures from the venturi meter in the basement. Chemical solutions are introduced into the sewage at a point in the force main downstream from the venturi meter; iron may also be applied to the sewer leading to the pump well. Five dry-feed machines are installed, of which three will be used for chemicals in the treatment of sewage and two will be provided for chemical conditioning of digested sludge.

A chlorine storage building is located adjacent to the dock, and delivery will be made in one-ton drums by barge. An overhead trolley will convey these drums to a storage room large enough to accommodate 45 drums, approximately a 23-day supply. Recirculating hot-water-type chlorine evaporators with a capacity of 6,000 lb. per 24 hr. are connected by duplicate pipe lines to the storage room and to the chlorine solution feeding machine. Application of chlorine to the sewage through rubber-lined pipe can be made either in the discharge line from the venturi meter or in the discharge channel from the clarifiers.

### Plant outfall

The main outfall for the plant, a 72-in. concrete pressure conduit with a capacity of 95 m.g.d., has been built 1½ miles to Rockaway Inlet, where it is connected to a submerged distribution chamber, 20 ft. inside diameter and 18 ft. high. Extending radially for a distance of 44 ft. from the center of the structure are three 42-in. cast iron outlet pipes, each of which will be divided by a Y-connection into two 30-in. cast iron pipes (Fig. 8). Only one of the three outlets will be completed and used at the present time. Each of the 30-in. sections is progressively reduced in diameter to a 10-in. pipe size over a distance of 170 ft. Short T-head risers (9 for each conduit) installed at the reduction point and terminus of the line, act as diffusers for the effluent into the tidal waters.

A 48-in. emergency bypass outfall has also been constructed which will permit diversion up to 70 m.g.d. to Shell Bank Creek adjoining the plant site.

Pipe for the main outfall has a wall thickness of 7 in. and was cast in 24-ft. lengths at Kenilworth, N. J. The joints are sealed with rubber gaskets and held together by means of two 1½-in. bolts drawn up to steel lugs welded to the anchors cast in the concrete on opposite sides of the pipes. In the subaqueous construction of the sewers two sections of the pipe (48-ft.) were coupled and the joint made up before the assembly was lowered into place. The double pipe sections were lifted with a steel truss "strong back" handled by a floating derrick. A collapsible frame pilot point was fastened at one end of the pipe (see Fig. 1, opposite) to serve as a guide in facilitating rapid insertion of adjoining sections under water. After the pipe was in position a diver removed the steel frame pilot point and drew up the bolts to close the joint. Using this method of procedure, it was possible to lay three 48-ft. sections of pipe in one working day.

The concrete distribution chamber, with walls 4 ft. thick and weighing 425 tons out of water, was precast and floated over a previously prepared wood pile foundation site in Rockaway Inlet, where it was lowered into place with a 350-ton floating derrick.

The Coney Island sewage-treatment plant is being built by the city of New York with a PWA loan and grant of $1,867,000. Thomas W. Hammond is commissioner of the Department of Sanitation and Walter D. Binger is deputy commissioner in charge of engineering. Design and construction of the plant are under the direction of Richard H. Gould, chief engineer, and William L. Sylvester, designing engineer; Alfred R. Glock, resident engineer, is in charge of the field operations.

The Northeastern Construction Co. is building the plant and the Merritt-Chapman & Scott Corp. is constructing the outfall sewer.

# Casting 72-Inch Concrete Pipe in Sections 24 Ft. Long

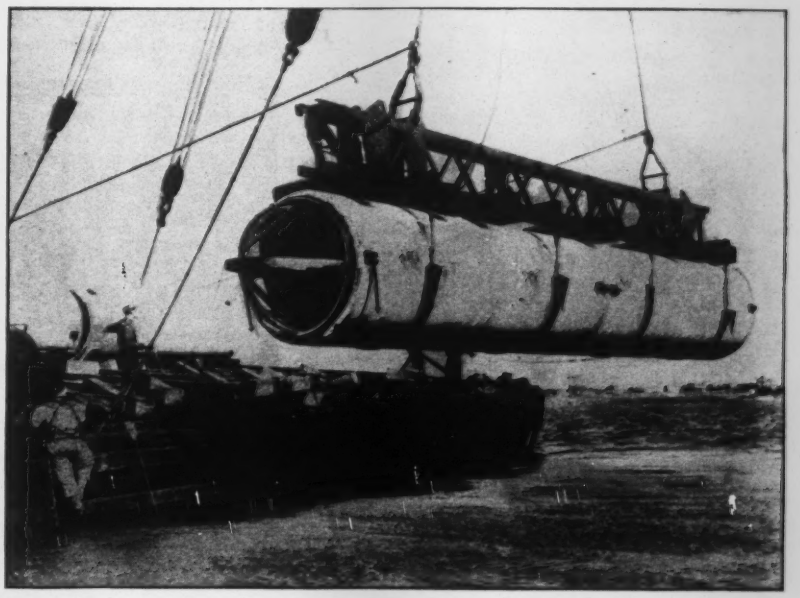
**Record size pipe adopted for Coney Island sewage-plant outfall to minimize number of subaqueous joints and facilitate underwater laying**

TO MEET a demand for a minimum number of joints and to provide a tight joint which could readily be assembled under water for the 6,375-ft. subaqueous section of the 72-in. outfall pipe line of the Coney Island sewage plant in New York City, the manufacturer supplied the pipe in precast lengths of 24 ft., with a joint which could be made watertight merely by pulling the pipes together. It is believed these are the longest lengths ever cast for pipe of this diameter.

These pipes, having 7-in. reinforced-concrete walls and weighing 22 tons each, were made at the Kenilworth, N. J., plant of the Lock Joint Pipe Co., from where they were trucked 10 miles on special trailers to Elizabethport, N. J. Here they were loaded onto lighters by the Merritt-Chapman & Scott Corp., which held the contract for the outfall.

The total length of the 72-in. outfall is 8,200 ft., of which 1,825 ft. is on land. Pipe for the land section was cast in 12-ft. lengths, since there was no equipment available at the site to handle the longer and heavier lengths used offshore.

FIG. 1—LAYING the 72-in. pipe was facilitated by a collapsible pilot point which guided the insertion of adjoining 48-ft. sections under water.



Within the 7-in. wall thickness of the pipe are two cages of reinforcing, consisting of No. 3 hot-rolled wire rods spirally wound on a motor-driven mandrel at a 3½-in. pitch. Before removing the mandrel the spirals are tied to ½-in. round longitudinal bars, ten on the inner cage and twelve on the outer. The spirals are also welded to the longitudinals at the ends and at several intermediate points.

At both ends of the inside cage the longitudinals are welded to heavy galvanized steel rings which form bell and spigot ends on each pipe. The spigot ring is formed by three plates, welded together so as to make a groove around the outer surface, in which a ⅝-in. round rubber gasket is placed. The bell ring has a smooth, cylindrical inner surface with a conical flare at the outer edge. When the pipes are pulled together, the bell ring telescopes over the spigot, compressing the rubber gasket in its groove and thereby forming a permanently watertight but flexible joint.

To provide means for pulling the pipe sections together and to hold them against wave action and possible shifting of the sand before backfilling on the subaqueous portion of the line, two 1½ x25-in. tiebolts were placed outside of each joint on the horizontal axis. These bolts, placed by divers, pass through projecting steel castings welded to anchor bars embedded in the pipe walls. Details of the joint and tiebolt connections are shown in Fig. 3.

All pipe was cast in a vertical position, using inner and outer steel forms erected on a cast iron base ring, the latter serving to hold the forms and joint ring in concentric positions. Four 24-ft. lengths of pipe and two 12-ft. lengths constituted a day's pour. A steel plate covered the top of the inner form and served also to hold the forms and joint ring in concentric positions at the top of the mold. Upon this plate the concrete was deposited from a conical-bottom, 1-yd. controllable dump bucket. A fairly dry mix with 1-in. stone aggregate was used. The forms and concrete bucket were handled by a locomotive crane.

On the outside of each set of forms were mounted two electric vibrators,

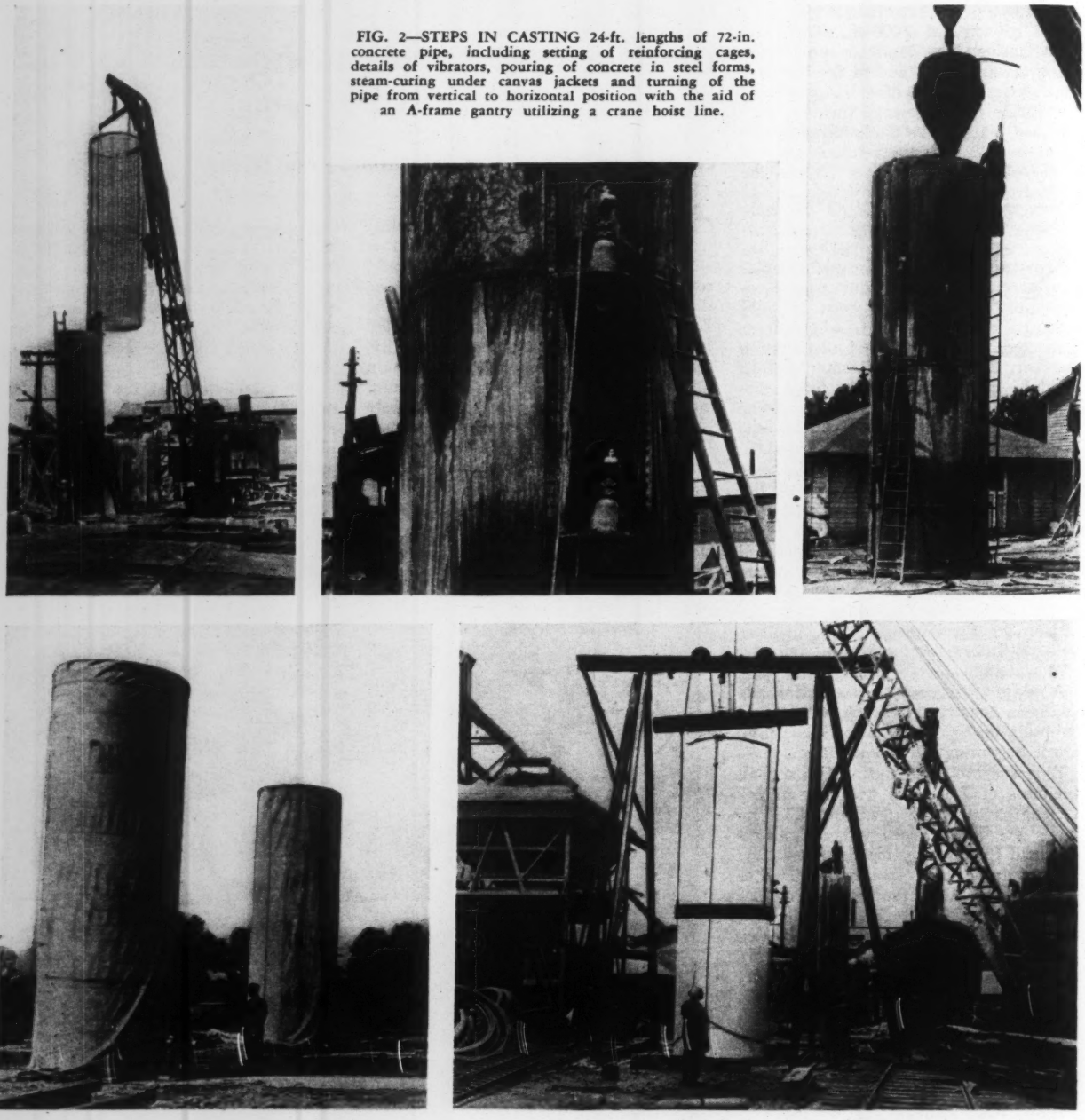


FIG. 2—STEPS IN CASTING 24-ft. lengths of 72-in. concrete pipe, including setting of reinforcing cages, details of vibrators, pouring of concrete in steel forms, steam-curing under canvas jackets and turning of the pipe from vertical to horizontal position with the aid of an A-frame gantry utilizing a crane hoist line.

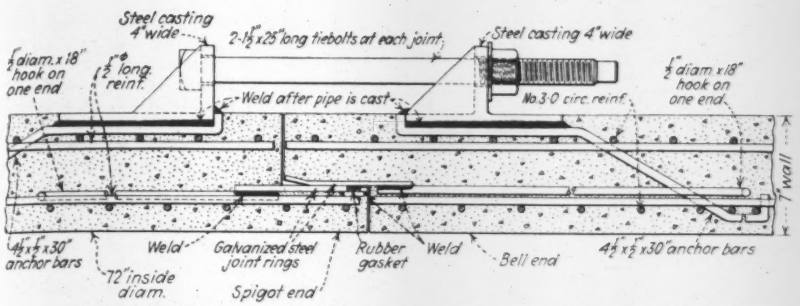



**FIG. 3—TIGHT FLEXIBLE JOINT provided by rubber gasket between welded steel rings and reinforced with external tiebolts.**

one 6-ft. from the bottom and the other above it at midheight. The lower vibrator was used until the forms were filled to its level, after which it was shut off and the upper one turned on until the form was filled. Some hand tamping was done at the top of each pipe.

### Steam curing

Upon completion of the concreting operations, the forms were covered with a canvas jacket (Fig. 2) and the pipe was steam-cured over night. The next morning the jackets were lifted long enough to allow stripping of the forms, after which they were replaced for additional steam curing until the following day. On the third day the pipe was turned to a horizontal position and rolled into storage. A novel double A-frame gantry was devised for turning the pipe, as shown in Fig. 2, the pipe being lifted by means of a steel band clamped at mid-point.

A special truck trailer was required for transporting the pipe to seaboard, each of the long sections making a full load. Loading onto the trucks was accomplished by rolling the pipe onto the trailer as it stood in a depressed roadway.

Casting of the pipe was carried on daily from April to August. L. G. Wilhelm was superintendent in charge of casting for the Lock Joint Pipe Co.

# Partial Treatment Advised for San Francisco Sewage

**Board of consulting engineers recommends two plants for the eastern and western drainage areas, respectively, with treatment confined to coarse and fine screening and aeration**

PARTIAL TREATMENT of the sewage of San Francisco, to be carried out in stages, has been recommended by a board of consulting engineers who state that complete treatment is not considered necessary in view of the large volume of water and other conditions favorable for disposal by diffusion and dilution. The board consisted of Harrison P. Eddy, Boston, chairman; Prof. Charles Dilman Hyde, University of California, secretary; Clyde C. Kennedy, San Francisco; and Prof. Leon B. Reynolds, Standford University. Although dated May 6, the board's report has but recently become available.

San Francisco has an area of 49 sq. miles. It is approximately square, fronting on San Francisco Bay at the east, Golden Gate Strait on the north, and the Pacific Ocean on the west. The southerly end abuts on San Mateo County. A spur of the Coast Range divides the city into two drainage areas, the larger of which is on the easterly side. Nearly all the city has combined sewers. Along the 23 miles of shore line there are 31 sewage outfalls, besides 10 storm overflows, all discharging at the waterfront or in estuaries. The board advised that the disposal works be designed to treat storm-water at the rate of 0.2 in. runoff per hour, in addition to the average flow of sewage. The 1930 population of San Francisco was 634,000, and the estimated population for 1960 is 1,100,000.

Important considerations in planning a sewage-disposal system for San Francisco are the many stretches of parks and other recreational water frontages, including a number of bathing beaches. "Virtually the entire west coast, south of Cliff House," says the report, "is one magnificient stretch of wide, sandy beach, facing the Pacific Ocean." The board of engineers found insanitary conditions along a number of stretches of the three waterfronts.

A study of tidal currents, floats, wind directions and other factors led the board to advise that the sewage from the eastern drainage area of the city be concentrated and treated at China Point and Hunter's Point (or possibly be combined) at the southeast corner of the city, and at North Point at the northeast corner. For the western drainage area it was recommended that most of the sewage be brought to Mile Rock in the northeast corner of the city. The sewage of a portion of the southwestern area of the city, instead of being carried to North Point, might perhaps be treated locally, together with the sewage of Daly City and adjoining areas in San Mateo County now discharging into San Francisco territory.

Only two of the proposed sewage-treatment plants are outlined in the report, the North Point and Mile Rock plants, which would serve the major part of the city. The North Point works, of 120-m.g.d. capacity, would consist of two sets of bar screens, one manually and one mechanically cleaned; grit chambers; venturi measuring flumes; aerating channels to give at least five minutes of aeration as an aid to grease separation; grease-skimming basins, with at least ten minutes of detention, equipped with moving skimmers; fine screens, with slots about ⅛x2 in. in size; and a 2,000-ft. submerged outlet, discharging through nozzles at a water depth of 50 ft.

The Mile Rock works, of 55-m.g.d. capacity, would include prechlorination apparatus for odor control; mechanically-cleaned bar screens and grit chambers; aerating channels for flocculation, flotation and removal of oil and grease; sedimentation tanks equipped for continuous sludge removal; sludge- digestion tanks, ferric-chloride sludge-conditioning equipment and vacuum filters.

The final effluent, after chlorination, would either be used wholly or in part for irrigation in Golden Gate Park or else discharged through the present Mile Rock trunk sewer. The gas from the sludge-digestion tank would be used so far as needed to heat the sludge, but there would be a surplus for power production.

Recommended for immediate construction is a pumping station and force main to deliver sewage from the Marina subdistrict in the central-northern part of the city to the present North Point outlet, at an estimated cost of $252,000; and, in connection with the Mile Rock project, $505,000 for pumping plants, force mains and other sewers; and $543,000 for the Mile Rock treatment plant, or a total of $1,300,000.

As soon as funds are available the board of consulting engineers advised the construction of the North Point treating plant and eccessories as follows: land for treatment site, $600,000; treatment and pumping plant and outlet to bulkhead line, $1,250,000; 2,000 ft. of submerged outlet pipe and diffusion system, $400,000; total, $2,250,000.

W. H. Worden is director of the department of public works, John J. Casey is city engineer, and A. J. Cleary is chief adminstrative officer of the city and county of San Francisco.

# Valuation Procedure Reviewed by Supreme Court

**Use of price indices alone is determining the value of the property of the Chesapeake & Potomac Telephone Co. condemned—Utility entitled to benefit by rise in price levels but may not pass on risk involved in price decline**

THE USE of price indices as the sole means of bringing the valuation of public utility property up to date was condemned by the U. S. Supreme Court in its decision rendered June 3 in a case brought to test the constitutionality of a value placed on the property of the Chesapeake & Potomac Telephone Co. by the Maryland Public Service Commission. The court also held that the district court that heard the case erred in attempting to set a value by deducting the company's depreciation reserve from its book cost, adding to the difference an allowance for working capital. In rejecting both methods the Supreme Court restated its oft-repeated pronouncement in valuation cases—namely, that *all* elements of value must be taken into consideration.

The decision was not unanimous. In a dissenting opinion, Justices Stone, Brandeis and Cardozo took the other members of the court sharply to task for completely rejecting the price-index method of valuation used by the Public Service Commission.

Abstracts from the decision and from the dissenting opinion are given in the following, also some extracts from footnotes appended to the dissenting opinion, as they cast added light on the manner in which the indices were used.

## Extracts from the decision

Early in 1933 the Public Service Commission of Maryland undertook an investigation of the rates and charges of the Chesapeake & Potomac Telephone Co. of Baltimore, and after extended hearings entered an order Nov. 28, 1933, directing the company to put into effect Jan. 1, 1934, reductions in its rates, sufficient to diminish annual net income by $1,000,000. The company filed a bill for temporary and final injunction; . . . and a decree was entered enjoining enforcement of the order. This appeal challenges the court's action.

The commission determined the value of the property at December 31, 1932, at $32,621,190; estimated the net revenue for 1934 as $3,353,793; allowed for reasonable return 6 per cent on value—$1,957,271—which the estimated revenue would exceed by $1,396,522. In view of the rise of the general price level during 1933, however, the commission required a reduction of but $1,000,000. In computing net income the commission accepted all the company's figures for current expense, except the annual allowance for depreciation, the amount claimed on this head being $2,173,000, and the sum allowed $1,720,724. The company insisted on a 7½ per cent return.

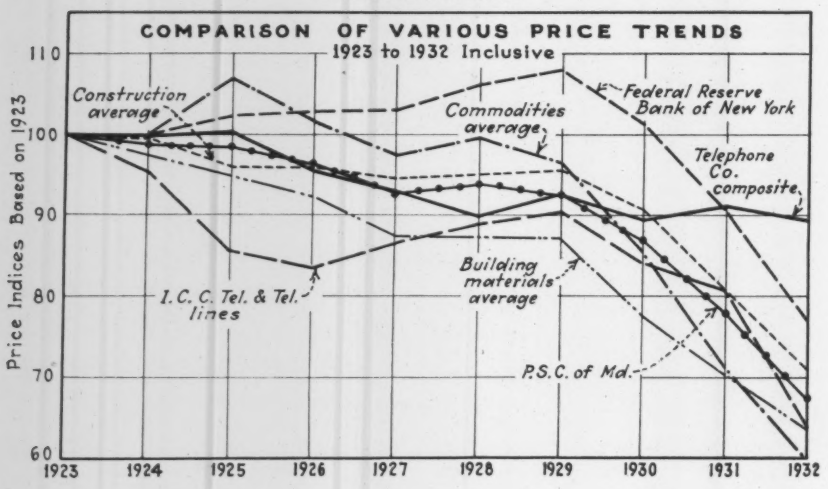
The controversy in the district court revolved around three matters—value, annual depreciation expense and rate of return. The court found the value of the property to be $39,541,921, the necessary depreciation expense $2,000,000, the probable net return under the commission's order $1,742,005, or at the rate of 4½ per cent as against 6 per cent, which the court held was the limit below which the return could not be reduced without confiscation.

In 1916 the commission valued the property and prescribed rates. In 1923 the company applied for an increase, the commission after a hearing fixed value at approximately book cost and refused to permit the rates to be raised. The district court, pursuant to a bill filed by the company, found the actual value exceeded book value by some $6,000,000 and enjoined the commission from enforcing the current rates. The commission acquiesced in the decision and passed an order adopting the court's finding of value and establishing new rates. So matters stood until the initiation of the present investigation.

The company's books accurately show installations and retirements of plant, and from them historical cost is ascertained to be $50,025,278 as of Dec. 31, 1933, with a depreciation reserve of $11,483,357. The commission made no appraisal of the physical plant and property but attempted to determine present value by translating the dollar value of the plant as it was found by the district court in the earlier case at Dec. 31, 1923, plus net additions in dollar value in each subsequent year, into an equivalent of dollar value at Dec. 31, 1932. Its theory was this: Value signifies in rate regulation the investment in dollars on which a utility is entitled to earn. The dollars when invested were free units of exchange value having an earning significance then and now only because they are such units of exchange. When invested, they represented in the plant so many poles, miles of wires, and other items of equipment; on the other hand, the same dollar units then represented certain quantities of government bonds, apartment houses, automobiles, food and services, etc. The dollars invested in the company's plant had no value unless they were exchangeable for other requirements and desires of the stockholders, and the corresponding requirements and desires of all persons who use the dollar as a measure of value. Thus a regulating body, in finding value, must find a number of universal units of earning power and purchasing power; that is, exchangeable dollars invested in place of present exchangeable dollars. How shall the relation be ascertained?

The commission thought it found the answer in commodity indices, prepared to show price trends. It selected sixteen of these, one covering as many as 784 commodities, falling into different classes, and weighted for averaging; others much less comprehensive; and its witness calculated by the use of each index the reduction in value of the company's assets considered as a conglomerate mass of dollar value from 1923, or subsequent date of acquisition, to 1932. As might be expected, the results varied widely. The lowest value found by the use of any index was $24,983,624; the highest $36,056,408—48 per cent higher. The commission then weighted these sixteen indices upon a principle not disclosed, giving them weights of from one to four, and thus got a divisor of thirty-one for the total obtained by adding the weighted results of all. This gave what

**COMPARISON OF PRICE TRENDS** as prepared by the Maryland Public Service Company to show relationship between its fair-value trend and other price trends. Ordinates are average indices for each year, except the 1932 ordinates, which are averages for the Chesapeake & Potomac Telephone Co.'s composite trend and for the I.C.C. Tel. & Tel. Lines; but, in all other cases, they apply to Dec. 31, 1932. All ordinates are based on 1923 as 100.



DEVELOPMENT OF A "FAIR VALUE TREND" BY A WEIGHTED COMBINATION OF VARIOUS PRICE TRENDS AS MADE BY THE MARYLAND PUBLIC SERVICE COMMISSION

| Identification of Price Trend | Wt. | Weighted Translators 1923 | 1924 | 1925 | 1926 | 1927 | 1928 | 1929 | 1930 | 1931 | 1932 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| U. S. Dept. of Labor, all commodities | 4 | 255.24 | 255.24 | 241.92 | 250.40 | 262.48 | 258.96 | 262.76 | 289.80 | 343.00 | 400.00 |
| National Assos. of Purchasing Agents (commodity) | 2 | 105.88 | 102.86 | 93.34 | 96.18 | 107.24 | 110.52 | 117.76 | 136.96 | 166.88 | 200.00 |
| Dr. Irving Fisher | 1 | 60.39 | 59.35 | 55.80 | 58.52 | 62.31 | 59.78 | 60.96 | 68.02 | 81.19 | 100.00 |
| Dun's | 1 | 70.51 | 70.73 | 67.73 | 72.42 | 71.41 | 68.88 | 70.07 | 76.78 | 90.90 | 100.00 |
| Bradstreet's | 1 | 51.25 | 53.51 | 49.38 | 52.88 | 53.88 | 51.84 | 54.33 | 64.08 | 78.60 | 100.00 |
| Engineering News-Record | 2 | 145.40 | 147.20 | 153.40 | 152.40 | 153.60 | 153.20 | 153.00 | 156.20 | 174.80 | 200.00 |
| American Appraisal Co. | 2 | 135.30 | 138.00 | 142.28 | 141.52 | 141.58 | 142.28 | 141.86 | 146.46 | 169.54 | 200.00 |
| Richey—old series | 2 | 150.60 | 150.40 | 153.60 | 153.00 | 155.00 | 153.00 | 149.00 | 154.40 | 175.60 | 200.00 |
| Consolidated Engineering Co. | 2 | 139.62 | 138.44 | 149.12 | 154.48 | 156.94 | 155.54 | 151.96 | 160.26 | 173.10 | 200.00 |
| Turner Construction Co. | 1.5 | 104.09 | 105.15 | 104.61 | 104.61 | 107.37 | 107.37 | 110.26 | 123.63 | 140.69 | 150.00 |
| U. S. Dept. of Labor, Bldg. Materials | 2 | 136.60 | 138.40 | 139.20 | 141.60 | 149.60 | 150.40 | 148.40 | 157.60 | 178.80 | 200.00 |
| Natl. Assos. of Purchasing Agents, Building Materials | 1 | 58.97 | 61.33 | 64.49 | 66.99 | 70.77 | 70.77 | 71.88 | 85.71 | 92.00 | 100.00 |
| Federal Reserve Bank of N. Y. | 2 | 154.22 | 154.22 | 150.58 | 149.70 | 149.70 | 145.46 | 143.02 | 152.38 | 170.66 | 200.00 |
| Baltimore Wages | 1.5 | 130.20 | 125.33 | 115.11 | 110.01 | 107.97 | 107.37 | 105.75 | 103.55 | 103.47 | 150.00 |
| I.C.C. Tel. & Tel. Lines | 3 | 192.51 | 202.26 | 225.00 | 230.76 | 222.21 | 216.87 | 213.03 | 229.29 | 238.41 | 300.00 |
| Company exhibit 35, less increase since 1929 | 3 | 199.44 | 211.44 | 213.75 | 234.00 | 279.72 | 274.23 | 300.00 | 300.00 | 300.00 | 300.00 |
| Totals | 31 | 2,090.22 | 2,113.86 | 2,119.31 | 2,169.47 | 2,251.78 | 2,226.47 | 2,254.04 | 2,405.12 | 2,677.64 | 3,100.00 |
| Fair-value translators | .. | 67.4 | 68.2 | 68.4 | 70.0 | 72.6 | 71.8 | 72.7 | 77.6 | 86.4 | 100.0 |

Note—These "fair-value" translators are based upon Dec. 31, 1932, as 100, and are intended to be, respectively, the percentage which, when applied to the value of the dollar at Dec. 31, 1923, and to the average value for each of the years 1924 to 1931, inclusive, will produce value as of Dec. 31, 1932.

the commission styled its "fair value index," which it applied to the 1923 value of the property then owned and to cost of all net additions in subsequent years, to obtain value as of 1932. The result, after adding some $660,000 for working capital, was a rate base of $32,621,190. The company submitted proof of estimated reproduction cost and accrued depreciation. The commission examined and criticized this evidence, but none was offered in opposition, and the valuation was based squarely on the figures obtained by the use of its index.

In the district court the company offered evidence of historical cost and of estimated reproduction cost less depreciation; the commission relied solely upon the figure resulting from trending the dollar value of plant owned in 1923 and cost of net additions subsequently made. The court held the indices used inappropriate for determining present value and discarded them. It purported to consider both book cost and reproduction cost; but, in fact, as plainly appears from the opinion, derived present value by the use of two figures only—book cost as of Dec. 31, 1933 ($50,025,278), less the entire depreciation reserve shown by the books ($11,483,357)—and thus fixed value at $38,541,921. To this is added $1,000,000 for working capital (instead of $660,000 allowed by the commission), giving a rate base of $39,541,921. Annual depreciation expense was raised from $1,352,284 as determined by the commission to $2,000,000. The appellants charge that in all these respects the court's action was arbitrary and cannot stand. We are not satisfied with the methods pursued either by the court or the commission.

* * *

This method [the commission's] is inappropriate for obtaining the value of a going telephone plant. An obvious objection is that the indices which are its basis were not prepared as an aid to the appraisal of property. They were intended merely to indicate price trends. Indeed the record shows that one index used by the commission and given a weight of 3—that of the Interstate Commerce Commission—bears a notation that it should not be used "in the determination of unit reproduction costs" upon individual properties. Doubtless the authors of the other indices would have issued a similar warning if they had supposed anyone would attempt such a use.

Again, the wide variation of results of the employment of different indices, already mentioned, impugns their accuracy as implements of appraisal. Sensible of this discrepancy, the commission attempted a rule-of-thumb corrective, by weighting the several indices upon a principal known only to itself, and thus rendered its process of valuation even more dubious and obscure. The possible factors of error are increased by the use of some indices such as that constructed by the commission's witness upon Western Electric prices. The evidence is that these apply to about 25 per cent of the company's purchases; that during the period of rising prices, 1924-1929, they rose more slowly than prices of other commodities and manufactured articles; that though in 1930 other prices fell, Western Electric's were raised an average of 10 per cent. In constructing an index from these prices, the witness disregarded the increase during the period 1930-1932. The commission gave the index a weight of 3 and applied it to all purchases of the company, although confessedly it was applicable to only one-fourth of them.

To substitute for such factors as historical cost and cost of reproduction, a "translator" of dollar value obtained by the use of price-trend indices, serves only to confuse the problem and to increase its difficulty, and may well lead to results anything but accurate and fair. This is not to suggest that price trends are to be disregarded; quite the contrary is true. And evidence of such trends is to be considered with all other relevant factors.

A more fundamental defect in the commission's method is that the result is affected by sudden shifts in price level. It is true that any just valuation must take into account changes in the level of prices. We have therefore held that where the present value of property devoted to the public service is in excess of original cost, the utility company is not limited to a return on cost. Conversely, if the plant has depreciated in value, the public should not be bound to allow a return measured by investment. Of course the amount of that investment is to be considered along with appraisal of the property as presently existing, in order to arrive at a fair conclusion as to present value, for actual cost, reproduction cost and all other elements affecting value are to be given their proper weight in the final conclusion.

But it is to be remembered that such a property as that here under consideration is a great integrated aggregate of many and diverse elements; it is not primarily intended for sale in the market, but for devotion to the public use now and for the indefinite future; and has, so far as its market value is concerned, no real resemblance to a bushel of wheat or a ton of iron. While, therefore, the owner of such a property must assume and may not pass on to the public the risk involved in a general decline in values, and may have the advantage also of a general rise in such values, it would not only be unfair but impracticable to adjust the value and the consequent rate of return to sudden fluctuations in the price level. For in its essence this is the sort of aggregate whose value is not fairly or accurately reflected by such abrupt alterations in the market. A public service corporation ought not, therefore, in a rate proceeding, to be permitted to claim to the last dollar an increased value consequent upon a sudden and precipitate rise in spot prices of material or labor. No more ought the value attributable to its property to be depressed by a similar sudden decline in the price level.

We agree, therefore, with the view of the district court that the method was inapt and improper, is not calculated to obtain a fair or accurate result, and should not be employed in the valuation of utility plants for rate-making purposes. As that court observed, it is not the function of a tribunal inquiring into the question of confiscation to set aside the legislative finding for mere errors of procedure. The duty of a court is merely to ascertain whether the legislative process has resulted in confiscation.

It is apparent from what has been said that here the entire method of the commission was erroneous, and its use necessarily involved unjust and inaccurate results. In such a case it is not the function of a court, upon a claim of confiscation, to make a new valuation upon some different theory in an effort to sustain a procedure that is fundamentally faulty.

* * *

There is a suggestion in the report to the effect that the commission's method was agreed to by both parties. We find, however, in the district court's opinion, a statement that the use of index figures was the subject of contest. We think the apparent contradiction is explained by reference to the record, which discloses that the company used price relation to obtain the present value of certain property, but separated from other sorts each kind of property so treated. This is comparable to the practice of the Interstate Commerce Commission in translating the value of specific railroad property, e.g., steel rails, by the use of the differential between the per ton price in 1914, the date of original appraisal, and the price prevailing at a later date. In this sense the company employed price indices; but it is plain that such a use of relation of values of specific

articles as of two given dates is quite distinct from the application of general commodity indices to a conglomerate of assets constituting a utility plant. Much is made of the fact that in the suit brought by the company in 1923 the district court applied a price index to cost, and thus determined the then value of the property. But this fact cannot justify the application of the same procedure here, in the face of the challenge of its propriety. In the present case the company did not put into evidence any such price indices as were used by the commission, but on the contrary offered evidence to show that the use of them as a sole criterion of value would be improper.

As already stated, the district court condemned the method pursued by the commission, and adopted one of its own. This consisted in deducting the company's depreciation reserve from book cost and adding to the difference an allowance for working capital. It is true that the court discussed the company's evidence as to cost of reproduction new, less depreciation, but did so only to indicate its disapproval of certain large amounts embodied in the total claimed and to reconcile the figures with its own estimate. A careful reading of the opinion leaves no doubt that all other measures of value were discarded in favor of cost-less-depreciation reserve.

It is clear that in a period of low prices costs incurred when the price level was much higher are not a safe guide in appraising present value. The court so conceded. The depreciation reserve was built up on the straight-line theory. The company asserted that the amount of the reserve did not represent observed and accrued depreciation at the date of valuation, as much of the total consisted of funds provided in anticipation of future depreciation and obsolescence. The court agreed and further found that on account of decreased demand for service, with consequent diminishment of obsolescence, the percentage of reserve had in recent years sharply increased. The question of going value was the subject of controversy. The court recognized that this element must be considered, but refused to make any separate allowance for it.

What the court did in fact was this: It found that book cost less actual accrued depreciation would probably give too high a figure. It sought to correct the probable error by deducting from cost the entire depreciation reserve, though conceding this exceeded actual depreciation. It felt that this large deduction would also redress any excess of cost over present value; and finally it said the result of its method would be appropriate to allow for going value.

Two quotations from the opinion will illustrate the basis of the court's action.

"We are not unmindful that at the present time the depreciation reserve is slightly higher than normal and, to the extent that it is, it is unfavorable to the company in the final result. . . . But this disadvantage to the company is, we think, offset by allowing it the full of its actual cost despite the generally lower trend of prices.

"All relevant facts considered, we are of the opinion that a fair allowance for going value is made when we value the telephone property as a whole as a going concern at its actual book costs less full depreciation."

The opinion in essence consists of the conclusion, that, all the circumstances considered, it will be fair to appraise the property at cost-less-depreciation reserve. This rough and ready approximation of value is as arbitrary as that of the commission, for it is unsupported by findings based upon evidence.

For the reasons stated we cannot sustain the district court's valuation. We have shown that the commission's order violates the principle of due process, as the measure of value adopted is inadmissible. It is not our function, and was not the function of the court below, to do the work of the commission by determining a rate base upon correct principles. The district court, upon finding that the commission reached its conclusions as to fair value from data which furnished no legal support, should have enjoined enforcement of the rate order. The court's action was therefore right, regardless of the method it pursued in reaching the decision that the order was confiscatory.

* * *

## Use of price trends favored

The use of price tends in valuation work was favored by Justices Stone, Brandeis and Cardozo. Extracts from Justice Stone's dissenting opinion and from the footnotes follow:

The commission [Maryland Public Service Commission] did not refuse to receive or to consider any of the evidence presented. Its error, if error there was, did not consist in receiving and considering the evidence submitted of indices showing changes in commodity and other prices. It would have been error for the commission not to have considered it. In *St. Louis & O'Fallon R. Co. v. United States,* this court set aside a recapture order of the Interstate Commerce Commission on the sole ground that the commission had failed to consider evidence before it tending to show that the reproduction cost of the structural property of the railroad was greater than original cost. The only evidence of this character disclosed by the record consisted of index figures showing the comparative price levels of labor and materials for 1914 and each of the subsequent recapture years. The valuation of the property by the commission was set aside by this court on the ground that the commission had failed to consider the evidence of increased value over cost. In *Clark's Ferry Bridge Co. v. Commission,* this court held that the supreme court of Pennsylvania, in sustaining the action of a state commission, rightly rejected engineers' appraisals and estimates of value in favor of a lower valuation by the commission based on cost and a study of charts showing the price trends of labor and materials from 1924 to 1930 inclusive. In affirming the judgment of the state court, this court expressly approved this method of arriving at fair value, although it was less meticulously and carefully applied than by the commission in this case, and held that the evidence of cost and of price trends, of the same character as those on which the commission acted here, outweighed engineering appraisals of the whole property, which the appellee here did not choose to offer.

* * *

As far as the results of the use of standard price indices are impugned by their variation, an examination of the present record will disclose that the results obtained by the application of price indices to the historical cost of plant are far less variable than engineers' valuations and in general are probably more trustworthy. To speak of either class of evidence as so accurate as to require a commission as a matter of law to accept it, or so inaccurate as to require the rejection of a valuation based upon it, is to attribute to the valuation process a possibility of accuracy and certainty wholly fictitious. Present fair value at best is but an estimate. Historical cost appropriately adjusted by reasonable recognition of price trends appears to be quite as common sense a method of arrival at a present theoretical value as any other. For a period of twenty years or more of rising prices, commissions and courts, including this one, have regarded price variations as persuasive evidence that present fair value was more than cost. I see no reason for concluding that they are of less weight in times of declining prices.

* * *

## Price indices used

Both the decision and the dissenting opinion refer to the price indices used by the Maryland Public Service Commission. Details as to their character and some information as to how they were used are given in the following extract from the footnotes of the dissenting opinion. Comparisons there made were cited in support of the statements made in the preceding paragraph.

Sixteen price indices were used by the commission [see accompanying table]. Five of them related to commodity prices and included the comprehensive and reliable index of wholesale prices prepared by the United States Bureau of Labor Statistics. Five indices of construction costs were included, prepared by trade journals and concerns allied with the construction industry. Two indices of the price of building materials were used. An index of general consumers' purchasing power, issued by the Federal Reserve Bank of New York, was added. A painstakingly prepared index of Baltimore wages was included in order to insure adequate representation of labor costs. To guard against any peculiarity in the price trends of telephone property, two specialized indices were also taken into consideration. One was the Interstate Commerce Commission index of telephone and telegraph property owned by railroads. That the Interstate Commerce Commission stated that "The indices represent territorial index factors and are not applicable for use in the determination of unit reproduction costs upon individual roads" does not lessen the value of the index as one element of the valuation or as a check on the results reached by other indices. Finally, an index based upon Western Electric prices for telephone equipment and apparatus was used (after elimination of a price rise in 1930, found by the commission to be artificial). This index is incontravertibly applicable to 25 per cent of the company property. It is not to be wholly rejected because it is not a perfect and a certain measure of the whole property.

These results were averaged. Since some of the indices were more accurate than others, and since some were more directly applicable to telephone property, they were assigned greater weights. It is clear that these were the considerations which influenced the commission's judgment as to the appropriate weighting. For example, the Bureau of Labor Statistics wholesale

price index received a weight of four; the Interstate Commerce Commission index of telephone and telegraph property and the index based on Western Electric prices each received a weight of three; all the other indices were given a weight of one or two. The results of the highest and lowest of the indices differed from the commission average only by 10.6 per cent and 23.4 per cent respectively. Eleven of the sixteen indices separately considered gave results ranging between $30,000,000 and $34,600,000. There is plainly a rather close clustering about the average of $32,610,327 found by the commission.

* * *

The lowest result obtained by the commission in the use of the sixteen classes of price indices was 76.6 per cent of the commission's valuation. The highest was 110.6 per cent. Against these differences of only 23.4 per cent and 10.6 per cent, the record shows that in rate cases before the Maryland Public Service Commission, the company valuations based on engineering appraisals had exceeded the commission's similar valuations by amounts ranging from 25.0 to 59.4 per cent. The average was 41.3 per cent. Most of the rate cases reported in the 1931 and 1932 public utility reports were examined. In the 1931 reports the company valuations similarly exceeded commission valuations by amounts ranging from 2.1 to 71.2 per cent. The average was 28.9 per cent. In the 1932 reports the company valuations exceeded commission valuations by amounts ranging from 7.7 to 135.4 per cent, averaging 57.4 per cent.

# Grouting Checks Leakage in Earthfill Dam

**Old earth dam that had been raised and provided with sheetpile cutoff of uncertain penetration made watertight by grouting the fill**

By E. M. Wilbur,
*Civil Engineer, Port Jervis, N. Y.*

THE recent repair, by grout injection, of an earth dam of the Port Jervis water department, the success of which is believed to have been established by more than seven months of satisfactory service under repeated full head, presents several features of interest. Also, the record of prior operations in raising the old dam, in an attempt to increase storage, presents an apt example of increased ultimate costs arising from lack of subsurface data, and from false economy in omitting adequate engineering services.

## Raising old dam

The old dam was located about a mile west and 500 ft. higher than the village of Huguenot, Orange County, N. Y., and impounded a small mountain brook. Built in 1887 with team and hand labor, about 40 ft. in height at the maximum section, with slopes slightly steeper than 1 on 1½, it was composed of miscellaneous borrow with a high proportion of cobbles and boulders. The impervious section consisted of a clay facing, about 3 ft. thick at the water line and probably thicker below. In defiance of the most accepted present principles of earth-dam design, this dam remained in fairly satisfactory service for 45 years. Leakage existed only in normal amount, varying with the pond height.

In 1930 the city purchased the water system from the original private company, and in 1932 the city authorities raised the dam about 8 ft., to provide 6 ft. of additional storage depth. No borings were made.

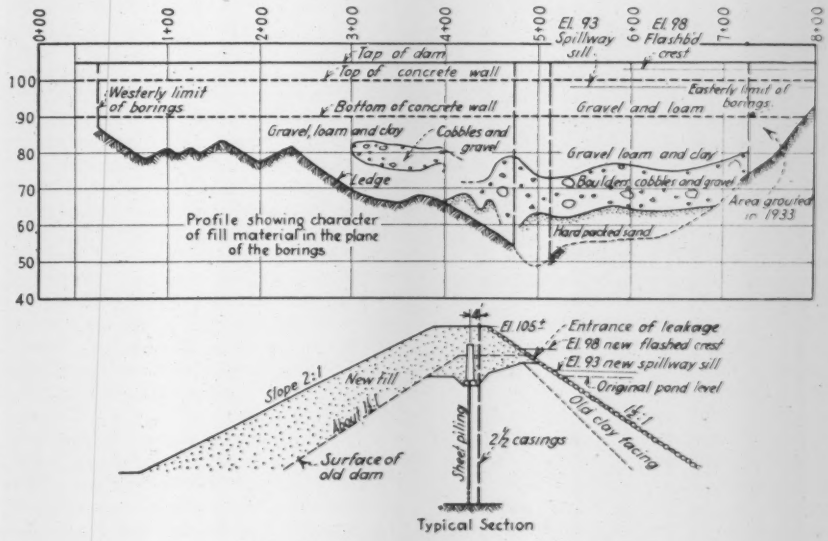
The work proceeded from August, 1932, to the end of that year. The top of the old dam was removed to a depth of about 10 ft., and the material was dumped over the downstream slope. Difficulty is reported to have been met in driving the steel sheetpiling; sections are said to have stopped at times, 25 to 30 ft. down, creeping badly both transversely and along the line. It also appears that when penetration stopped above the desired depth, persistent hammering was continued until the pile was assumed to have struck bedrock, or penetrated well below the original ground line. The probable condition of these piles can be surmised from photographs of piles removed from the Bourne and Sagamore bridge cofferdams at Cape Cod Canal (*ENR*, Jan. 3, 1934).

The steel sheetpiling membrane was capped with a 10-ft. concrete corewall. Work was then completed by dumping from trucks a gravelly loam fill, bringing the dam top to the desired elevation, and the downstream face to a 1-on-2 slope. The upstream slope of the old dam was retained. The cost of this attempt to provide additional storage was about $40,000.

During the raising, the pond had been drained as low as possible, and remained down during the winter. It filled rapidly during the spring runoff, and when it reached about El. 96, or 2 ft. below the new flashboard crest, alarming leakage (very muddy) broke through at the rate of nearly 3 cu.ft. per sec., with a slump in the top upstream face and visible entrance of water along a 50-ft. stretch. Drawing the pond down to the new spillway sill at El. 93 reduced the flow by 90 per cent and the color cleared up. Local repairs were made to the damaged section, with home-made drilling and grouting equipment, by grouting at the face of the sheeting to about 20-ft. depth below the concrete wall footing.

A year later, however, to the day (March 31, 1934) water again broke through when the pond filled, with similar conditions and effects, except that the slump and the entrance of water took place 300 ft. west of the repaired section. The thin body of new fill in front of the corewall, as the pond rose

SECTIONS OF EARTH DAM made tight by grouting embankment with a mixture of cement and fine loam soil.



above the old clay facing, admitted water, which found free passage, with rapid erosion, in and down to the face of the sheeting, and thence to any point of egress through or under the steel. The condition was now judged to be general and thorough general repair was obviously necessary if the intended 6-ft. depth of additional storage was to be obtained.

### Grouting decided on

A blanket fill of rolled earth was considered, but its cost was estimated to be practically equal to the preceding job; it would involve complete drawdown of the pond for the season and would focus attention on failure of the first project. It was decided, as an alternative, to make wash borings to bedrock or to an impervious stratum and to seal the fill in front of the corewall and sheeting with an earth and cement grout.

An ordinary test drilling rig was employed, using 2½-in. casings. A careful log was kept of the borings, recording every possible item of information for guidance in subsequent grouting. The holes all lost wash water at varying rates down to bedrock, except when passing through an occasional clay lens. Cobbles and boulders in the fill gave trouble, two or three starts being frequently necessary before the casings would go to the desired depth.

Throughout the deeper portion of the dam, at about 30 ft. from the surface, the casings entered a very porous body of gravel and cobbles, about 10 ft. thick. The first row was driven on a 12½-ft. spacing, offset upstream from the center of the core to clear the corewall footing. The first few casings were driven on a batter to approach the face of the sheeting, but this was abandoned, as it slowed up the work. Observed results as to saturation level, porous or impervious layers, discoloration of leakage, etc., were spotted daily on a large-scale profile work sheet. The lowest saturation level, El. 63, was found around station 5, near the section where sheetpiling had not reached ledge.

### Grouting procedure

Compressed air was not used in grouting for various reasons. This being a relief project, it was desired to use hand labor rather than hired equipment. Frequent moves made lightness of equipment desirable. Also doubt was felt concerning the possible effect of an accidental shot of compressed air into the upstream body of the dam under a head of water. (The pond was not drawn below the spillway sill, except as water was gradually used during the summer.)

The pumping outfit consisted of a 4½x12-in. horizontal double-action hand force pump, bolted to a small platform, with a hopper mounted on the suction pipe. A gasoline-operated ½-yd. mixer was used to prepare the grout. The pressure control was approximate. Before beginning work, a pressure gage was put on the discharge, and the maximum water pressure was noted which one man and then two men could set up. With this as a guide, the operating pressure was estimated from the amount of effort put forth by the pump crew.

The working pressures, as thus roughly determined, varied from zero up to 35 lb., running up to a momentary maximum of probably 100 lb. when forcing the last batch into the deeper lifts. The ability to stop instantly the entrance of grout was considered a safeguard, considering the hydraulic jacking effect that existed. Progress with this outfit compares favorably with previous experience with air grouting in ledge, using compressor and 1-bag grout mixer.

Grouting followed about 50 ft. behind the drilling and proceeded in horizontal lifts about 2 ft. thick, starting with the deepest holes around station 5. That is, a pipe with bottom at, say, El. 55 was pumped to refusal at this depth, pulled (maintaining pressure) until it again took material, and so on until the bottom reached El. 57. The next pipe was then connected and similarly pumped to El. 57, and so on. The casings were then pumped to El. 59, the section being worked gradually extending up along the surface of the bedrock each way. Grout traveled, at times, up to 75 ft. along the dam from the pipe being worked, sometimes bypassing several casings to appear in one beyond. The saturation line gradually rose as the successive levels were completed. As grouting approached El. 90, a ⅛-to-¼-in. crack usually appeared in the top of the dam, directly over the corewall near the casing being pumped. Eventually the grouting was continued until material had been forced out at the face of the dam in a practically continuous streak along El. 95 to 98. This occurred, in general, when the bottom of the casings reached El. 90 to 95. The casings were then withdrawn. In the meantime, additional casings had been driven, 25 to 30 ft. deep, on staggered spacing with the first set, the intention being to make sure, in any case, of an impervious bridge between the corewall and the clay facing of the old dam.

After all wash-boring casings had been grouted and withdrawn, test holes were put down, using a shot drill where the grouted layers were set up hard, to check results. The fill was found in general practically impervious down to 30- to 35-ft. depth. Below this some water was lost from the casings. From Sta. 5-50 to 6-50, however, it was found that the first casings had stopped on boulders, mistaken for ledge, and in this section an additional row of casings was driven with the shot drill, through the grouted level and porous stratum below into fine sand, and were then grouted, using thin rich grout and heavy pressures.

The mixture varied from 1 part cement to 2 parts soil, to 1 cement to 6 soil. Leaner mixes could be handled, but it was desired to fill the voids with material which, when set, would offer fair resistance to erosion. The soil used was selected in the bank, by inspection, to approximate the characteristics of satisfactory mud-jacking soil, as reported by A. M. Wintermeyer in *Public Works*. It was a very fine red sandy loam, with considerable clay content. The bulk of the material would, it is judged, pass a 40-mesh sieve. Test samples set up very well with the cement proportions used, but the 1:6 mix was rather weak, about like dried clay. Very fine sand was tried, but it took too much cement to make it work at all and clogged badly in the pump.

The fluidity of the grout was varied according to the character of the strata being grouted. Several casings seemed at times to be connected to an endless cavern (twice material was forced out at the downstream toe), and in these a mix of a consistency of thick gruel was pumped without much trouble. For average conditions 40 to 50 per cent water content was used, depending largely on the richness of the mixture in cement.

When pumping was suspended on a casing, it had to be lifted a few feet to avoid freezing into the grout. If grout stood in a casing after it was uncoupled, it was flushed out with a hose. The pump and connections were taken apart and washed out twice daily, or whenever pumping was suspended for any length of time.

It appears that, in grouting porous earth strata, little effect is obtained in sealing voids below the bottom elevation of the pipe. They must be worked from the bottom up.

A byproduct of the operation was about a 60 per cent reduction in the amount of normal leakage. Also a part of the remaining flow shifted about 50 ft. downstream, coming up through seams in the red shale ledge.

The over-all cost of the repair job was about $17,000, not including the water commissioner's salary and engineer's pay. The quantities were:

| | |
|---|---|
| Borings, lin.-ft. | 2,750 |
| Cement, bags | 7,377 |
| Soil for grout mix, cu.ft. | 20,000 |

The unit costs were as follows, the figures being in each case the over-all cost applied to the number of units—that is, each unit cost times total units equaled total cost of job.

| | |
|---|---|
| Per foot of borings, drilled and grouted complete | $6.18 |
| Per cu.yd. of grout, dry volume | $17.00 |
| Per cu.yd. of fill treated, approx. | .83 |

H. S. Sheldon, water commissioner, had personal charge of the work. The foreman and drill rig were furnished by the Acker Drill Co. The writer was called in on the leakage emergencies, and was retained by the water department to originate and supervise the method of repair.

# Recent Sewage Plant Developments Call for Fresh Approach to Design Problems

By Samuel A. Greeley
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TODAY is a most opportune occasion to take a birds-eye view of practice in sewage treatment. This is because of the surprisingly many developments during the last four or five years. No competent and conscientious engineer can make use of a design for a sewage treatment plant prepared, say, in 1931, without revising it to include many new devices. There would be little change in the fundamental principles or in the basic plant loadings, but the present day design would include new procedures for handling screenings, grease and sludge and would comprise a more economical and efficient plant through improvements in the design of many of the structures, the use of by-products and closer operating control. The relatively large increase in equipment for sewage treatment has added much to the task of the engineer who has to determine the design and select and acquire for his client the many desirable items of equipment.

A greater range in the degree of treatment is now available and this permits a closer coordination of the extent and cost of sewage treatment with the actual varying needs of the waterway receiving the effluent and with the strength and condition of the sewage to be treated. Thus, problems of design have increased during the past few years to include the selection and acquisition of equipment from a number of alternates and the adjustment of the extent of treatment to the needs of the community so as to make the most reasonable use of the capacity of the natural waterway for assimilating sewage effluent.

The development since 1930 is illustrated by the following paragraphs briefly describing some of the new items of equipment, more or less following the flow of sewage through a treatment plant.

Screenings were buried or occasionally incinerated and in large plants were difficult to dispose of. Several screenings grinders are now available which macerate or break up the screenings and return them to the sewage as suspended solids, as is being done at Baltimore, Grand Rapids and elsewhere. With this device finer screens can be more readily used.

In larger plants, grit is now generally removed by scraper mechanisms and the grit cleaned and sometimes washed. This type of grit chamber avoids close velocity control and the attendant loss of head thus reducing the cost of pumping and perhaps the amount of deep excavation.

**● Screenings are macerated, grit is washed, grease is removed in many of the recently built plants.**

**● Aeration tanks have been greatly widened, revolving sprinklers now are common, sludge gas is utilized in power engines and vacuum fillers produce sludge cake of surprisingly low water content.**

**● Sludge incineration has been accepted and chemical treatment is definitely established.**

A recent step has been the introduction of grease separation and removal tanks, generally between the grit chambers and preliminary sedimentation tanks. Such tanks were in use in Germany prior to 1930, but have only recently been included in this country.

### Round tanks now possible

Prior to 1930 preliminary sedimentation tanks were built square or rectangular in plan to fit the then available mechanisms for removing scum and sludge. Now round tank mechanisms have been adopted for several large plants, especially for final sedimentation in the activated-sludge method.

The design of aeration tanks in activated sludge plants is quite different now. Up to 1930 the widest aeration tanks were 22 ft. (Wards Island, New York City). Recently several have been designed 30 ft. wide and the aeration tanks of the new Chicago Southwest project are to be 32 ft. 9 in. wide. This increased width results in a material reduction in the amounts and costs of concrete, reinforcing steel, air piping, aeration plates and their appurtenances. In some designs, economies have been accomplished by substituting a control house for the long operating galleries for housing valves, meters and sludge wells. A number of new mechanisms for aerating and agitating sewage to produce activated sludge have been designed and given some use.

Whereas five years ago most of the trickling filters were built with fixed nozzles for spraying the sewage effluent over the broken stone, now many more plants are designed with revolving or traveling distributors. Several feet less head is required by the revolving distributor which often results in lower costs of excavation or pumping.

### Gas used for power

In sludge digestion the outstanding development has been the much increased use of sludge gas for power. The first sizeable sludge gas engine in this country (so far as my records show) was installed at Charlotte, N. C., in 1928. A few years prior to that time a sludge gas engine had been installed at Birmingham, Eng., and there is now a capacity of more than 1,500 hp. at this plant. Today there are more than fifteen major sludge gas engine installations in operation or under erection at sewage treatment plants in this country. Two-thirds of the horse power required to aerate sewage can usually be developed in this way.

The use of sludge gas has directed attention to the design of digestion tank covers and to the storage of gas. Some digestion tanks have been designed with gas holder covers; and in some large projects, fixed concrete covers are being built with separate gas storage tanks. There are several devices for stirring the sludge in tanks having fixed covers. Thus, the possibilities in the design of sludge digestion tanks are much wider than five years ago when attention was pretty well limited to fixed covers with mechanical equipment of the Dorr or Hardinge type and to floating covers. Prior to 1930 practically all heat insulation was provided by earth embankments around digestion tanks. In 1932 at Decatur, and in 1935 at Madison, heat insulation was provided by brick shells around the outside of the tanks to form an air space.

### Sludge dewatering

A marked increase has been made in our knowledge concerning the operation of mechanical devices for dewatering sludge, particularly the vacuum filter. At the present time mechanical dewatering of digested sludge or of raw sludge, with or without chemical treatment, is established as a useful item of equipment, particularly in the larger installations. Sludge cakes with moisture contents from 80 down to 65 per cent can be produced in routine operation

with different kinds of sludge. Advances have also been made in centrifugal machines for dewatering sludge and perhaps screenings, but have been used in routine operation in only one instance in this country.

Greater dependability in the mechanical dewatering of sludge and the difficulty in large plants of finding places for the disposal of large quantities of sludge has lead to much investigation into the incineration of sludge during the last few years. Experiments were conducted on a large scale at the West Side plant in Chicago which have lead to the adoption at the Calumet plant of a large installation (75 tons of dry solids per 24 hours) for drying and incinerating the excess sludge from an activated sludge plant. The heat value of the dry sludge is to be used with powdered coal for power production. A sludge incinerator of a different type has apparently come into successful routine operation at Dearborn, Mich.

Many factors during the last few years, including the availability of more and better equipment for handling and controlling sewage, chemicals and sludge, have brought about a considerable development in the chemical treatment of sewage. Chemical treatment plants are now in their third year of operation at Dearborn, Mich., and at Shades Valley, Birmingham, Ala., and, after a considerable adjustment effort, now appear to have reached a reasonably stable routine operation.

## Chemical treatment efficiency

Plants for intermittent chemical treatment are under construction for the Coney Island district of New York City and for Waukegan, Ill., and have been approved for Minneapolis and St. Paul; one at Perth Amboy, N. J., went into operation in June, 1935. It has been found, under favorable conditions of operation and with sufficient quantities of chemicals, that chemical treatment can remove 75 per cent or more of the suspended solids and some 70 per cent of the total oxygen demand of the sewage. It thus provides a degree of treatment intermediate between plain sedimentation removing 30 to 35 per cent, and trickling filters or activated sludge removing 85 to 92 per cent of the oxygen demand.

## Wide treatment range possible

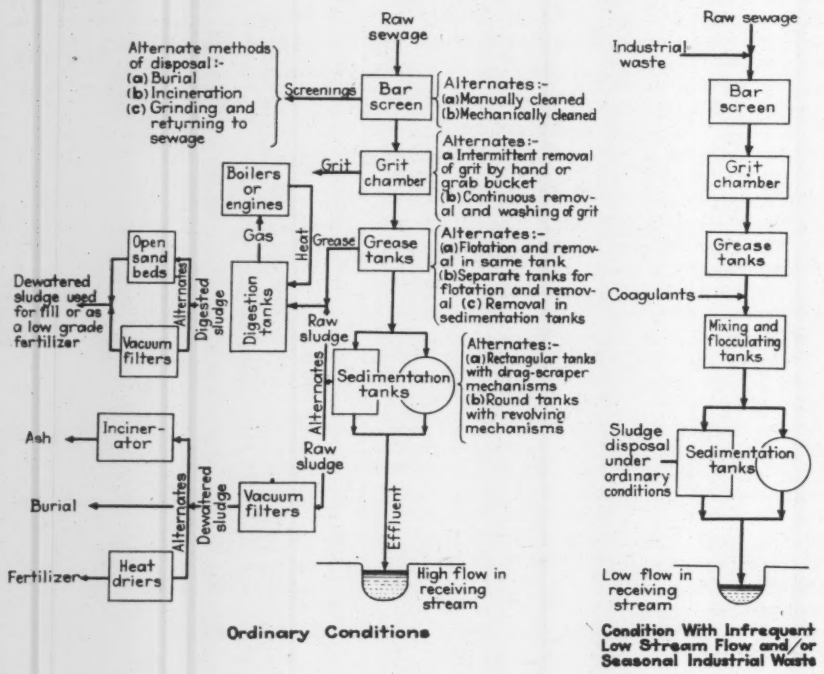
The chemical treatment plants at Dearborn and Perth Amboy are equipped with effluent filters of the Laughlin type. Originally designed to filter the effluent from chemical treatment, considerable study has been given during the last year to the use of such effluent filters with plain sedimentation, and tests along this line have been made at the small Coney Island testing station of the Department of Sanitation of New York City. If some form of effluent filter becomes available for use with plain sedimentation, there will be available still another intermediate step in sewage treatment. Thus, beginning with fine screens and passing on to plain sedimentation, plain sedimentation with effluent filters, chemical treatment with and without effluent filters, and the more complete methods of activated sludge or trickling filters, with chlorination where needed, the engineer can fit the degree of treatment more closely to the needs of the waterway receiving the effluent than was possible five years ago. Thus a development of the last few years and a likely trend in the future is the design of sewage treatment plants closely related to the needs of the waterway receiving the effluent, with a resulting better over-all efficiency and economy. Not only can the seasonal needs of the waterway for recreation, irrigation or low flow be more closely followed, but variations in the characteristics of the sewage due to such things as seasonal loads of industrial waste can be more economically provided for. This increase in the number of alternate arrangements in a sewage treatment plant has greatly increased the amount of engineering skill and work required for the best design of a sewage treatment plant.

In addition to the foregoing major lines of development in the sewage treatment field, a great many relatively minor but none the less important forward steps have been made. Such items should be noted as the valuable work of the Sanitary District of Chicago on the selection and durability of paints for sewage treatment plant structures and the accompanying specifications, the adaptation of rate controllers from waterworks practice to the control of sludge withdrawals from final settling tanks, the greater use of steel through the development of the welding process and improved design of piping through the development of alloys.

No resume of the present status of sewage treatment would be complete without reference to the much greater attention that has been given in the last few years to odor control. A marked reduction in odors can be made if covered structures are provided where the sewage is first exposed at the treatment plant and the mixture of sewage gas and air is collected and deodorized. Sometimes this trapping of the sewage gases is extended to the effluent conduits of the preliminary sedimentation tanks. It appears likely that the moderate aeration of the sewage provided in connection with grease separation tanks tends to release some of the odorous gas from the sewage and thus to improve measures of odor control which depend on trapping and deodorizing the gases released during the first steps in sewage treatment. Such elimination or control of odors often permits the use of more centrally located sites and, as a consequence, a saving in the cost of intercepting sewers.

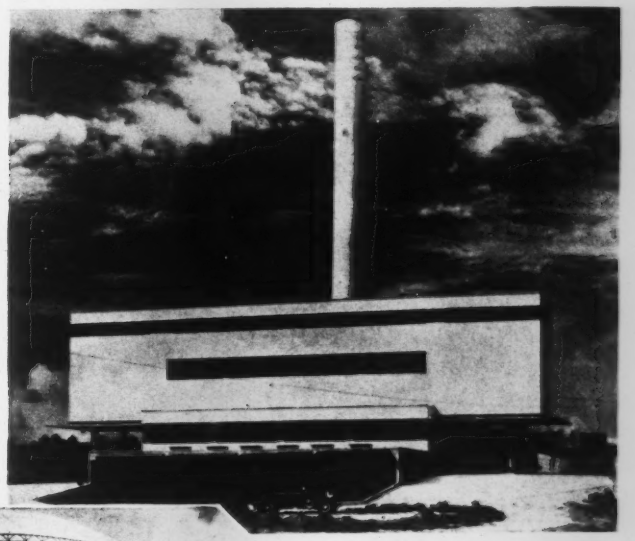
The above illustration shows graphically a typical problem in the sewage treatment field.

**TYPICAL PROBLEM in sewage disposal for preliminary and intermediate treatment to meet seasonal variations in sewage and in stream conditions.**

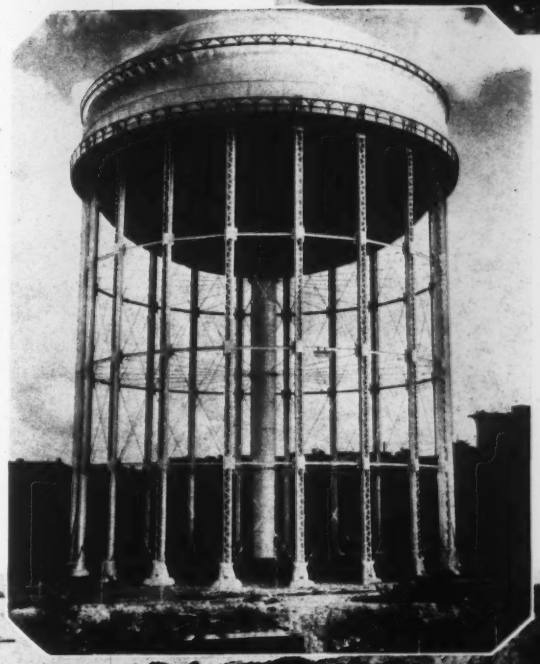


# LASTING VALUES

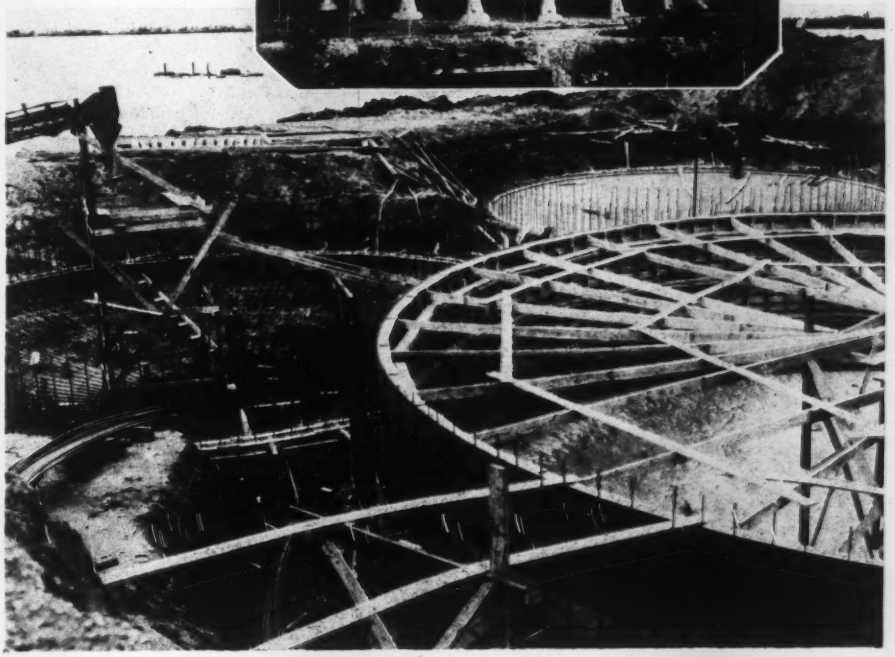
## Where Some Cities Have Put Their PWA Money



Shreveport, La., recently completed this modern and modernistic incinerator, using $180,000 of PWA loan and grant funds.

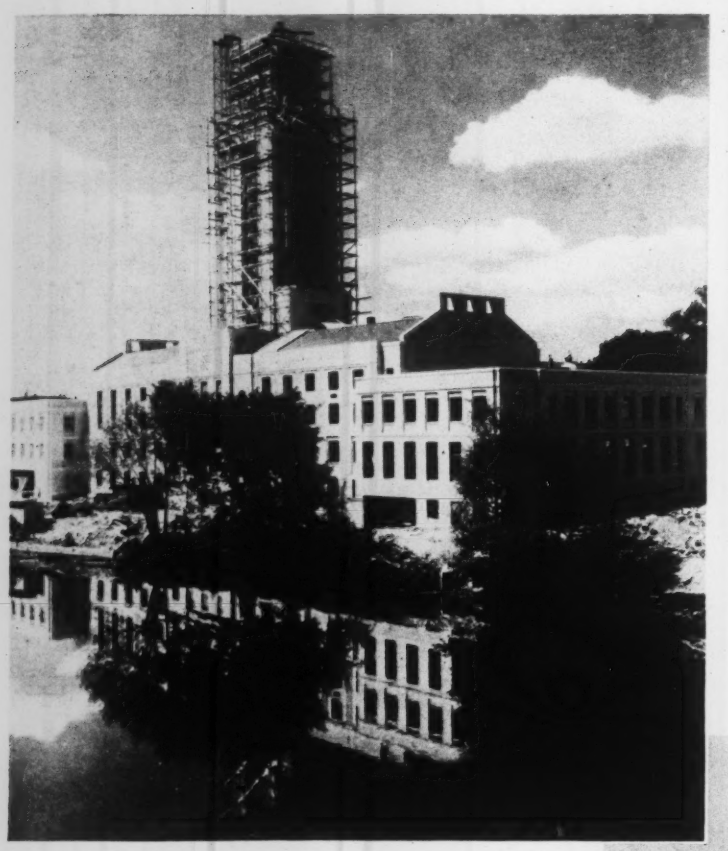


Elevated water storage for Spartanburg, S. C., is supplied by this new 1½ m.g. steel tank.



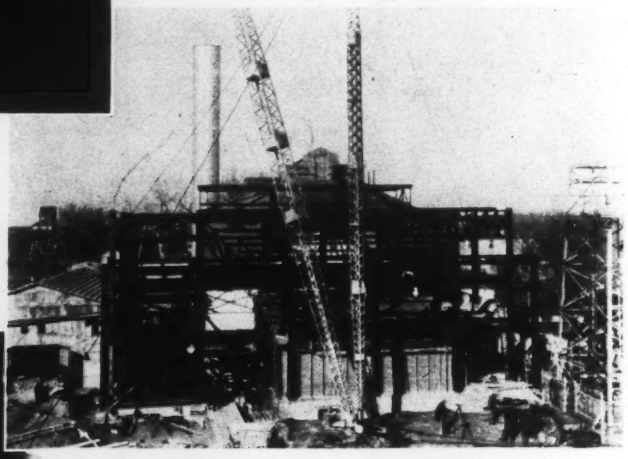
Cleveland is using an $8,990,000 allotment for new sewage facilities, including these sludge digestion tanks on the shore of Lake Erie.

# MORE PWA INVESTMENTS

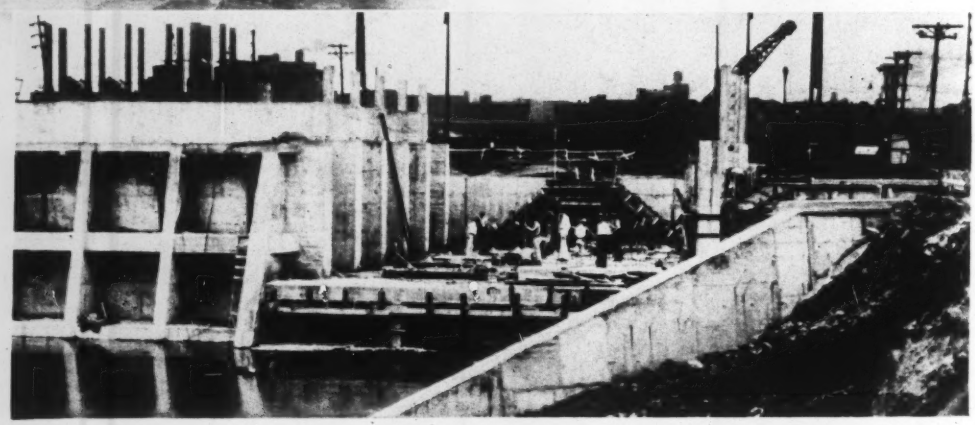


All city departments of Pawtucket, R. I., will be housed in this new city hall on the banks of the Providence River.

More light and power for McPherson, Kan., will originate in this new municipal plant.



Wilmington, Del., has provided new office facilities (left) for the administrative divisions of its water department.



Discharge end of a $2,360,000 drainage project involving Cahokia Creek in East St. Louis, Ill. Pumps installed in this structure will lift the water into the Mississippi River when it is at a higher stage than the creek.

# Nationwide Control of Water Pollution Proposed

**Plan for the coordination of federal and state agencies, adequate control legislation and the creation of a demonstration unit on the Potomac River system recommended to National Resources Committee**

DEFINITE conclusions and recommendations directed toward a program of sound planning in nationwide control of water pollution have been submitted to the water resources section of the National Resources Committee by a special advisory committee appointed December, 1934, to consider the several aspects of water pollution as a major element in the planned use and control of water resources. The primary object of the report, which has just been released, is to aid in estimating the significance of pollution, so that policies can be formulated to promote a sound harmonization of water usage.

The advisory committee of technicians, chosen for their expert knowledge of the subject from various angles, consisted of W. B. Bell, Bureau of Biological Surveys, U. S. Department of Agriculture; Col. Glen E. Edgerton, office of Chief of Engineers, U. S. Army; A. C. Fieldner, Bureau of Mines, U. S. Department of the Interior; Elmer Higgins, Bureau of Fisheries, U. S. Department of Commerce; Thorndike Saville, professor of hydraulic and sanitary engineering, New York University; R. E. Tarbett, Public Health Service, U. S. Treasury Department; and Abel Wolman, Maryland State Department of Health. This committee assembled and analyzed an extensive array of data from which conclusions were drawn and recommendations made regarding the status of water pollution laws, the relation of pollution to standards of public health and other biological considerations, to industrial waste treatment and to the status of water quality. The following summary and comments have been abstracted from the report of the committee.

*Water Pollution Legislation*—Changes in the laws of most, if not all, states are recommended to control water pollution effectively, and the following principles are held to be desirable for incorporation in any new legislation:

1. Adequate administrative control.
2. Delegation of power to the administrative agency to determine what constitutes the pollution prohibited by the statute, and to establish limits of pollution.
3. Mandatory power, that is, power to compel the installation of suitable works, and to force other appropriate action.
4. No limitation on the bonding or taxing power of municipalities with respect to work ordered by the administrative agency.
5. Power to require the provision, through sewerage districts, sanitary districts, or otherwise, of facilities that will enable municipalities and industries to comply with the law.

A survey of state agencies indicated that no appreciable demand exists for an extension of federal control over water pollution, but these agencies generally are in favor of cooperative relations with the federal government to obtain financial aid, to exchange research data and to coordinate local measures of control. The interstate compact method, although offering a hopeful means of dealing legislatively with regional problems of water utilization, has not been sufficiently tested to judge of its possibilities in the problem of pollution administration and control, the committee concluded.

*Pollution and Public Health*—Public apathy and the cost of remedial measures are the basic causes of lack of progress in controlling water pollution. According to the committee,

> "Sewerage systems are available to over half the population of the United States, or, in other words, to about 68,000,000 persons . . . The sewage from approximately 28,400,000 persons, or about two-fifths of the urban population, receives treatment; about half of it receives both primary and secondary treatment. This indicates how large a proportion of the urban population disposes of sewage without treatment prior to discharge. Probably not all of it needs treatment, but a considerable part of it does."

*Other Aspects of Pollution*—Pollution inimical to fish, water fowl and other wild life, involves large if indeterminate losses. Despite the great interest of sportsmen's organizations, insufficient action has been taken to abate nuisances and abuses, or even to appraise the nature and extent of the effect of pollution. A sound and thorough educational campaign in this field was advised by the committee.

*Industrial Waste*—The prevention of pollution due to undesirable industrial wastes demands the active cooperation of industry because of the individual methods of treatment that are necessary. Industry wastes present a problem that cannot be solved by general methods of sewage treatment and wherever practicable, efforts should be directed toward recovery of valuable ingredients from wastes, rather than solely toward treatment to render them inoffensive.

*Quality of Water*—Standards of water quality are used in this country only to a limited extent, and no general agreement exists as to the standards that should be applied to various waters. Studies for such standardization, establishing limits of water pollution applicable to various water uses, should be comprehensive in scope and should enlist the services of experts having specialized experience in water pollution problems, and competent to evaluate the economics of the situation.

## Recommendations

In general, the committee concluded that any program of water pollution control should include agencies of the federal and state governments that are concerned with the matter and the branches of industry that are responsible in part for pollution or are seriously affected by it. An important detail of such a program involves the inclusion, in the control organization, of regional authorities, metropolitan districts, or local abatement districts; to date such agencies have entered into such control to only a limited extent.

In order to stimulate the construction of pollution abatement works, it is suggested that funds for the purpose be made available by the federal government to local public and private agencies on a grant or loan basis. Lacking any precedent for the designation of appropriate bases for such allocation, the committee recommended the creation of a demonstration unit on a selected river system. Such a demonstration unit on an interstate river system of some magnitude, involving several states and the federal government, would be best suited for a demonstration of the possibilities of (a) better coordinated water pollution control legislation in the several states, and between the states and the federal government, (b) more adequate administration procedure by state agencies, (c) the development of the legal and administrative procedure for regional or metropolitan pollution abatement authorities, (d) the coordination of municipal sewage disposal projects with state-wide or interstate projects, (e) clearing up unsolved problems of treating industrial wastes, (f) the extension of cooperation with industry, and (g) the stimulation of public demand for adequate control of water pollution.

## Potomac River district

The committee was of the opinion that the logical method of handling

problems of domestic and industrial waste pollution on any interstate stream is to consider the stream in its entirety so as to develop any program on the basis of the entire drainage area appertaining thereto. Since experience in the legal, administrative, engineering and financial phases of such an enterprise has so far not disclosed many of the precedents for action, it was recommended that a demonstration drainage basin unit be established for developing by trial and error the various solutions proposed. To make the most complete and valuable use of such a demonstration unit, one preferably should be chosen which is sufficiently small in size to be flexible in adjustment, sufficiently close to Washington for consultation, negotiation and review, sufficiently well advanced in detailed major study and in which actual corrective field construction could be undertaken in the immediate future, at least on major parts of the work. The committee, after carefully reviewing a number of the possibilities, selected the Potomac River drainage basin as satisfying all of the criteria suggested above.

The Potomac River drainage basin would provide a proposed district of approximately 14,000 square miles, and it is sufficiently close to Washington to lend itself to careful and continued scrutiny. It contains a number of domestic sewage treatment problems which, although relatively small in size, have the same characteristics as larger undertakings elsewhere. Industrial wastes in the region are of considerable volume and cover practically all of the types which now confront the rest of the United States for solution. Coal mine wastes add another problem of general interest and, in a river regulating program designed for purposes of stream pollution control, offer an additional problem to be studied. At certain points in the stream, pollution has already reached the point of nuisance, and dissolved oxygen conditions on certain stretches have become decidedly objectionable. The river has been carefully studied by federal, state, local and industrial agencies for over 20 years and the four states involved have had voluntary interstate agreements for a number of years.

A tentative program was prepared involving the expenditure of $15,000,000 on the Potomac River system, and it was felt that the cost involved was sufficiently low to be within the range of federal participation. For the general administrative control of this drainage basin, it was recommended that an administrative board of five members be created, one each from the states of West Virginia, Pennsylvania, Maryland and Virginia, to be appointed by the governors of these respective states and to be approved by the National Resources Board. The fifth member of this administrative board should be appointed by the National Resources Board. For purposes of direct contact with the National Resources Board, it was further recommended that the present advisory committee be constituted the directive agency to consult with the administrative board.

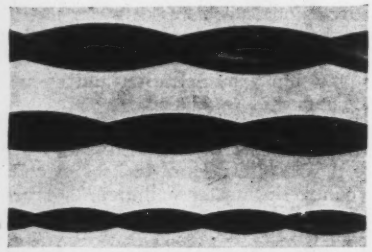
# Cold-Worked High-Strength Bars Tested for Concrete Reinforcing

A SPECIAL TYPE of concrete reinforcing steel new to this country but used in Europe since 1928 has been the subject of some tests recently carried out at Columbia University at the instance of D. B. Steinman, consulting engineer, New York. Known as Isteg steel reinforcement, it consists of two plain round bars twisted together cold. During the twisting operation the bars are also stretched, as their ends are held against longitudinal movement. The steel is thus cold-worked in both tension and torsion. Both yield and ultimate strengths are increased, the respective averages in these tests being 47.2 and 13.7 per cent.

With the further strength advantage resulting from the smaller diameter of comparable Isteg bars, these respective averages were increased to 63 and 23 per cent. Bond values also were appreciably higher than for either plain or deformed bars.

The program included, in addition to tension and cold-bend tests on the steel, load tests on rectangular and T-beams. The majority of the steel was structural-grade billet, but some comparative tests were made using intermediate-grade steel, which also gave satisfactory results. The Isteg bars were twisted together in 17½-ft. lengths, at room temperature, to a specified pitch of 12.5 times the diameter of a single bar. Concrete control cylinders averaged about 3,300 lb. per sq.in. at 28 days.

As a part of the tension tests, strain measurements were taken, and the average modulus of elasticity was determined. This was 30,124,000 for plain round rods and 22,854,000 for the Isteg bars. As a result, it was concluded that the value of $n$ for Isteg bars can be taken as three-quarters of the value used for the plain rounds.



**ISTEG reinforcing formed by twisting together two bars of ordinary-grade steel, thus cold-working them and raising both yield point and ultimate strength.**

In the cold-bend tests in which the bar was bent through 180 deg. around a mandrel of single-rod diameter, none of the specimens showed any indication of cracking. No difficulty was experienced, and no appreciable displacement of the elements resulted when the end of the bar was bent into a hook.

Ten reinforced-concrete beams 12x12 in. in cross-section and of 9-ft. span were loaded at the third points, and stresses in the concrete and steel were measured. The percentage of steel reinforcement ranged from 0.45 to 1.25 per cent for the respective types of reinforcing bars. The plain round and deformed bars were designed for a steel stress of 18,000 lb. per sq.in., and $n$ equal to 10. The respective values for the Isteg reinforcement were 27,000 lb. per sq.in. and $n = 7.5$. In one group of beams the concrete design stress was 700 lb. per sq.in. for plain round and deformed rods and, 1,015 lb. per sq.in. for Isteg reinforcement. In another group the concrete design stress was 1,120 lb. per sq.in. for beams with deformed rods and 1,450 lb. per sq.in. for beams with Isteg reinforcement. Dr. Steinman reports that for the first group of beams, those reinforced with Isteg bars had 28 per cent less reinforcing steel but proved 24 per cent stronger in ultimate load. Averaging the results from tests of groups 1 and 2, the beams with Isteg bars had 31 per cent less reinforcing steel but proved 9 per cent stronger in ultimate load.

In so far as economy is concerned, the test results indicated that the maximum loads carried by the beams per unit of sectional area of reinforcing steel were in the ratio of 1.000:1.105:1.760 for the plain round, deformed and Isteg bars, respectively. Conclusions of a similar nature resulted from the T-beam tests.

The test results further showed that beams designed with Isteg steel at 27,000 lb. per sq.in., together with a 15 per cent increase in concrete stress without reducing the value of $n$, will have a higher factor of safety than beams designed with plain or deformed bars at 18,000 lb. per sq.in. with the usually specified concrete stresses. Identical conclusions from tests made in leading European countries have formed the basis for official approval of Isteg steel in various governmental codes, with these indicated increases in design stresses permitted.

# Varied Methods of Public Cleansing Reviewed at International Congress

**Second International Congress for Public Cleansing Meets in Frankfurt am Main, Germany, Aug. 19-23, with twenty-three nations represented—Garbage and refuse collection and disposal in several countries discussed—Street cleaning equipment displayed**

By Harrison P. Eddy, Jr.
*Consulting Engineer, Boston, Mass.*

FOUR YEARS AGO there was held in England an international congress of municipal officials and sanitary engineers for the exchange of view on problems of public cleansing, street cleaning, garbage and refuse collection and disposal and related subjects. This year the second congress was held in Frankfurt am Main, Germany, Aug. 19 to 23, with 23 states represented by more than 200 delegates. The United States was represented by William J. Galligan, assistant superintendent of streets, Chicago, chairman of the joint administrative board of the American Society of Municipal Engineers and the International Association of Public Works Officials, by Alfred E. Roche, president, International Association of Public Works Officials, and by the writer in his capacity as president of the American Society of Municipal Engineers. Other representatives were George A. Soper, New York, and Robert B. Brooks, St. Louis.

The international committee met on Sunday in advance of the formal meeting and determined tentatively that the third congress will be held in Budapest, Hungary, in 1938 under the chairmanship of Alfred Bällo, director of the public cleansing department of Budapest.

The states represented were: Algeria, Austria, Belgium, Bulgaria, Chili, Czechoslovakia, Danzig, Denmark, Finland, France, Germany, Great Britain, Holland, Hungary, Italy, Luxemburg, Mexico, Poland, Rumania, Spain, Sweden, Switzerland, United States.

On Sunday evening, in the large hall of the Frankfurterhof, there was a general reception giving opportunity for delegates to mingle and to meet each other. This evening, with no set program, was perhaps one of the happiest events of the entire congress. It might well be copied at many of our annual engineering society meetings.

The first formal session, on Monday morning, was given over to opening speeches and addresses of welcome. The retiring president, J. C. Dawes, Inspector of Public Cleansing, Ministry of Health, London, called to the presidential chair A. Schröder, Director of Municipal Conveyance Service of Frankfurt am Main, at the same time presenting him with a diploma of honorary membership in the British Institute of Public Cleansing, a reciprocation of the honor extended to Mr. Dawes by the German association on his appointment as president.

In welcoming the delegates, Dr. Frick, the Reichs Minister under whose portfolio come both public health matters and municipal administration explained that the legal position with respect to public cleansing matters had been improved by the new German parish constitution. Under this new constitution only evidence of public need is required to make mandatory the establishment of such services as sewerage, refuse collection and street cleaning.

The Lord Mayor of Frankfurt, Dr. Krebs, followed Dr. Frick in welcoming the guests, presenting an amusing sketch on street cleanliness in Frankfurt from the time centuries ago when pigs ran about the streets at will and aldermen were forced to go to their meetings in wooden shoes because of the filth in the streets and were required to take off their shoes before the meeting to avoid carrying in the dirt, up to present days when the city is a model for cleanliness.

Responding graciously in behalf of the English-speaking members, George A. Soper of New York, the dean of the delegation from the United States expressed the conviction that the better understanding between individuals made possible by acquaintances made and renewed at such conferences was leading to a better understanding among the countries represented.

Dr. Schröder, in his presidential address on the hygienic and economic importance of public cleansing, reviewed some of the major stepping stones. He referred to the British Public Health Law of 1848 for combating epidemics, as the turning point in our fight against disease. He also emphasized the value of the work done by the associations of public cleansing, the British Institute of Public Cleansing, founded in 1898; the Dutch association, founded in 1907; and the German association founded in 1912. (Subsequently Dr. Soper called attention to the work of the American cleansing society, known as the International Association of Public Works Officials, which was organized in 1920, and the American Society of Municipal Engineers, organized in 1893).

## Street cleaning

Alfred Bällo, Budapest, in a paper on street cleansing and snow removal, outlined the fundamental requirements, including a sewerage system adequate to transport street-sweepings and snow; an unlimited water supply so that great quantities may at all times be available for flushing; that street widths should be divided into several strips for pedestrians, cycles, carriage-ways, and green borders. Carriage-ways, he said, in the interest of economy, should be strictly limited in widths to actual requirements, any surplus width to be in the form of green borders. He also advocated accelerating education in public cooperation in keeping waste matter off the streets and sidewalks, by laws permitting punishment of offenders on the spot by the police. The public humiliation would be effective.

As dust-fixing agents for macadam roads, hygroscopic salts such as magnesium or calcium chloride, are effective in climates where there is sufficient moisture in the hot summer air, according to Mr. Bällo, but this may be a costly practice; certain mineral oil distillates have been found effective but experiments with tar oils, different oil emulsions, water glass, glue and starch products, have not met with much approval.

Mr. Bällo, reviewing snow removal, treated melting apparatus most briefly, merely stating that it is used in several cities, but is generally more costly than carting snow away. He stated also that portable narrow-gage railways are sometimes used. In closing, Mr. Bällo emphasized that local circumstances were of such importance that best results could be obtained only by trial in each city, not by blindly following practice in another city.

Mr. Glieber of Dresden disagreed with views expressed by Mr. Bällo in the matter of night street cleaning and stated that on account of the noise this must be done at night only when day traffic makes night cleaning imperative. He also urged great caution in the discharge of solid or dry material into sewers, as did Mr. Robinson of Newcastle. Both of these speakers urged investigation before motorizing departmental equipment merely because it was the up-to-date thing to do.

### Refuse collection

In a paper on the collection of refuse in the United States Carl Schneider of New Orleans emphasized the difference in conditions in Germany and the United States, both as they affect the composition of the refuse and the personal problems involved in collection. He stated that there seemed to be a slight increase in private contract collection of refuse, principally in our smaller communities. He also discussed separation of materials in the household and in collection, kinds of receptacles used, their capacity and location, frequency of collection, regulations for household treatment, and deplored the lack of enforcement of regulations for household handling of refuse.

Mr. Schneider regretted a lack of standardization and progress in design of collection vehicles in the United States. Approving New York City's new designs, he said they are still far short of the dustless systems of Europe, although he admitted that the European vehicles designed for use with closed household container of uniform size are not adaptable to bulky American refuse.

In closing he spoke favorably of the work of the Committee on Uniform Street and Sanitation Records of the I.A.P.W.O., with which the A.M.E. is now cooperating.

### Financing refuse disposal

Mr. Bällo enquired as to experience in the financing of refuse disposal works in cities where it is difficult to secure funds for their construction. The writer outlined practice in this field in the United States as the country having most experience with contract disposal, taking up length of contracts, life of plant and cost of its amortization, sanitation, interest rates, ability to trade from day to day in materials salvaged, as supply, demand and prices fluctuate, the trend in contract versus municipal disposal, etc. Mr. Dawes said there is only one private plant in England. This has been in operation 30 years. He said that British towns have no difficulty in financing construction when the loans have been approved by the Ministry of Health. Mr. Noppen, Director of Public Cleansing, *Amsterdam*, stated that municipal disposal in Holland was preferable to contract disposal. Dr. Soper stated that studies made two and one-half years ago indicated that municipal disposal in the Borough of Brooklyn would be cheaper than disposal by the contractor who had done all this work for the previous thirty years.

### Collection costs in France

In France the cost of collection, according to Mr. Chalumeau, chief engineer of Lyons, varies from 7 to 15 francs per tonne ($0.19 to $0.41 per ton), after eliminating low figures where work is not well done and figures where local conditions make the cost too high for general comparison.

Mr. Chalumeau gave the average composition and the calorific value of refuse in seven French cities in springtime as follows:

TABLE I—ANALYSES OF FRENCH REFUSE

| Towns | Waste Paper | Rags | Wood | Metals | Glass and China | Bones | Vegetable Matter | Dust |
|---|---|---|---|---|---|---|---|---|
| Boulogne Sur Mer | 2.52 | 10.5 | ... | 11.5 | 9.8 | 0.85 | .... 64.83 | |
| Paris | 1.1 | 2.4 | 2.1 | 2.1 | 1.8 | 0.6 | 28.2 ..... | 42.2 |
| Tours | 8.56 | 4.30 | 0.56 | 6.84 | .... | 1.10 | .... 78.50 | .... |
| Lyon | 12.6 | 5.34 | 1.42 | 1.43 | 5.85 | 1.14 | .... 72.22 | .... |
| Bordeaux | 11.3 | 3.1 | 1.4 | 1.9 | 2.1 | 2.1 | .... 78.10 | .... |
| Avignon | 14.9 | 2.4 | 6.4 | 1.3 | 1.4 | 0.9 | 21.7 ..... | 51.0 |
| Aix en Provence | 5 | 4 | 4 | 10 | 4 | 1 | .... 72 | .... |

Note: Calorific value of the refuse in the city of Lyons; 1490 calories. (Lower caloric value in the raw state, i e with 39.3 per cent water).

Mr. Chalumeau pointed out the wide variation in character of refuse in passing from Southern France to the North. A corresponding difference is found in the United States. Night collection has been abandoned in France and collection hours are generally limited to from 6 to 10 a.m. This short day makes it desirable to use a vehicle which is adaptable to other uses during the balance of the day, a practice which does not appear to be generally feasible with us.

Some French cities refuse to collect large objects such as discarded furniture, but generally they are collected. Refusal to collect such objects is an inconvenience and expense to the public (and frequently in the United States this material does not get removed from the premises unless the city does collect it.) This is a distinct disadvantage of the European "dustless" vehicles which can be loaded only through the small openings provided for the uniform dustbin.

### Refuse collectors

In France and particularly in Paris, much attention is being given to developing vehicles which shall be closed to prevent material from blowing about and which shall have mechanisms for compressing the refuse in order to get full loads. Types illustrated by Mr. Chalumeau include a simple moving floor in the bottom of the truck; one in which the entire cylindrical body revolves while helical vanes inside force the material to the front; one in which the refuse is pushed forward by a piston; one in which the divided body is revolved vertically about a transverse horizontal axis, thus emptying the rear loading portion into the larger forward storage portion; one in which the rear door of the body which is hinged at the top, is pushed inward by means of two levers worked by oil pressure; and one in which an elevator at the rear lifts the refuse into the body at the top, and a piston compresses the load. A number of these have racks around the top of the body to permit carrying large objects.

In connection with vehicles, it is important to consider the type of material which is to be handled. The principal value of these designs to those interested in American refuse collection, lies in their challenge to our ingenuity in designing vehicles to meet our needs which will be useful, rugged and simple.

Another ingenious plan of refuse collection, described by Mr. Chalumeau is the pneumatic pipe line. This is like the underground pneumatic mail tubes. Discharge shafts are about 60 meters apart. It is in use in three French towns. Mr. Chalumeau is about to install this system in a hilly district in Lyons where vehicular collection would be difficult. He suggests that this method may be convenient in the older parts of some cities where the streets are narrow, crooked and badly congested with traffic. Dr. Soper stated that this method was once tried in New York City and also in New Jersey.

### Electric collector trucks

Twenty-three communities in France now use electric trucks for collection. With gasoline at 1.9 francs per litre, the gasoline-propelled truck costs about 75 per cent more than the electric truck to operate, including ordinary repairs, but not general overhauling. In competition over the same daily round of 21.5 km. where the conditions were exactly the same the gasoline truck gained 17 minutes in hauling time, but lost 14 minutes in collection time. The time saved by the gasoline truck being thus only 3 minutes in an entire day's work.

Mr. Chalumeau closed with the sound advice to choose very simple solutions to questions of this sort, and such as permit of good substantial construction.

Dr. Krause, in a paper on refuse collection in Germany stressed the importance of the household refuse con-

tainer and of a dust-free collection. He pointed out the widespread use of the dust-free systems as shown in the accompanying table. In addition to the 164 German towns with a population of 19,487,000, there are said to be 42 non-German towns using these systems. Table II shows the distribution of populations served in this manner and indicates that 53 per cent of the country's population in towns of over 5000 population is so served.

TABLE II.—SIZE OF GERMAN CITIES USING DUST-FREE SYSTEMS

| Towns with Inhabitants | Inhabitants in total number of towns | Inhabitants in the towns equipped with dust-free collection | |
|---|---|---|---|
| | | Number | Per cent |
| Over 100,000 | 19,679,000 | 15,544,000 | 79.0 |
| 50–100,000 | 3,515,000 | 1,565,000 | 44.8 |
| 20– 50,000 | 5,022,000 | 1,785,000 | 35.6 |
| 5– 20,000 | 8,542,000 | 593,000 | 6.9 |
| Total-over 5,000 | 36,758,000 | 19,487,000 | 53.0 |

TABLE III.—GERMAN TOWNS USING EXCHANGE AND DISCHARGE SYSTEMS

| Towns with Inhabitants | Number of towns equipped | Number and per cent of the dust-free-equipped towns using: | | | |
|---|---|---|---|---|---|
| | | Exchange system | | Discharge system | |
| | | Number | Per cent | Number | Per cent |
| Over 100,000 | 34 | 8 | 23.5 | 26 | 76.5 |
| 50–100,000 | 22 | 0 | 0.0 | 22 | 100.0 |
| 20–50,000 | 55 | 9 | 16.3 | 46 | 83.7 |
| 5–20,000 | 53 | 5 | 9.5 | 48 | 90.5 |
| Total-over 5,000 | 164 | 22 | 13.4 | 142 | 86.6 |

## Dust-free collection of refuse

There are two classes of dustless collection systems. In the exchange system the filled household receptable is exchanged for a clean, empty one, the filled containers being taken either directly to the point of ultimate disposal or to a transfer station, at either of which it is emptied and thoroughly washed. In the discharge system the covered household containers are emptied directly into the collection vehicle in the street, through mechanisms designed to prevent the escape of dust. Table III shows the number of towns using each of these methods. With respect to the relative use of the two systems the exchange system is, of course, the most sanitary, but its cost is probably somewhat greater.

Dr. Krause states that when a city desires the use of uniform household containers (designed to fit the mechanisms of the "dustless" collection vehicles) it buys them and furnishes them to the public. Householders pay "about 10 per cent higher than the purchase price. This increase serves for social purposes. Less well off people get them at a reduced price or on installments and paupers get them quite for nothing." He states also that introduction of uniform containers is impossible without compulsion. The latter will be readily secured in Germany since adoption of the new parish laws of January 30, 1935.

The collection service sometimes is financed by charges based on the number of containers, or of rooms, or the frequency of collection or on a value basis such as the ground rent, the pre-war rental value or the buildings tax.

## Fuel experiments

Dr. Krause states that the necessity to reduce imports due to the falling off in exports has resulted in experiments with trucks burning local fuels. Trucks using these fuels were on exhibition, including wood gas and charcoal gas generated on the truck, and compressed propane and methane. It is understood that federal order has now made it compulsory for cities to limit the purchase of new vehicles to those using these fuels; similar orders are reported to have been issued recently in Italy.

In comparing American and German practice it is significant to note Dr. Krause's statement that the standard 35-liter container (about 9 gallons) "is as a rule large enough to take the week's refuse of one family"—that is ashes, rubbish and garbage.

In discussing English practice, Mr. Ardern, City Cleansing Superintendent, Westminster, London, stated that the character of refuse is thought to be changing (probably somewhat toward that in the United States) due to a gradual change in house heating to electricity (since the installation of the high tension "grid") and to oil. Because of the difficulty in controlling the type and condition of household containers towns are beginning to supply them, either free or below cost or on a rental basis.

In the past, Mr. Noppen said in his paper on refuse utilization in the Netherlands, municipal refuse found a ready market as a manure on lands reclaimed from the sea; in fact, some districts were actually reclaimed by its use. Before sewerage systems were installed the fertilizing value of refuse was enhanced by the addition of feces, the mixing taking place in pits in which the compost was formed. With the installation of sewerage systems and the development of cheap artificial fertilizers it became more difficult to get rid of refuse in this way. During the war when artificial fertilizers were difficult to secure, a demand again arose, but it immediately dropped. Nevertheless, in some cases waste land is still improved by the use of refuse. In the case of the capital city, the Hague, the refuse of nearly one half million people is permitted to rot, is then screened and sold as manure. Mr. Noppen stated further that because of the presence of traces of metals it is also suited to combat certain crop diseases.

Dumping at sea is practiced only by one town, Den Helder (pop. 34,000)—probably because of Holland's traditional good-neighbor policy and the knowledge that much would wash back on the beaches of neighboring towns.

Dutch refuse, as that in other European countries, is changing in character and contains much more paper than formerly.

Incineration of mixed refuse in Holland is limited to three cities. Rotterdam's plant was built by Heenan and Froude in 1912. Electricity is generated and supplied to the town. In Amsterdam electricity is generated in the plant which was put in operation in 1919. Amersfoort also has a mixed refuse incinerator, built in 1933. Dordrecht officials expected that the construction of such a plant would be authorized at a meeting held on Sept. 4.

While the above plants are all which burn mixed refuse it is said that nearly all Dutch cities have a furnace for large objects such as cases, baskets and old furniture.

## Refuse disposal in England

England's dean of public cleansing, J. C. Dawes, inspector of public cleansing, Ministry of Health, in a paper on the disposal of refuse, methods employed in England and Wales, discussed comprehensively the five methods generally used. Perhaps his most significant statement, however, was "that indiscriminate or the crude deposition of refuse on land is not regarded by us as a method (of disposal) at all, but the negation of one." This practice, he says, cannot be justified on sanitary grounds.

He also emphasized that there is no single best method for all communities but that there is always a best method for every community and that the art of sanitary and economic disposal is to discover this method.

The use of controlled tips has increased rapidly. In this method the refuse is deposited in a layer not over 6-ft. thick and is each day thoroughly covered with a layer of earth at least 9-in. thick. If the material covered at any one time is "mainly fish, animal or other organic refuse" it should be covered immediately with at least two feet of earth or other suitable material. The refuse as deposited "must be packed very tightly. There must be no cavities." The tipping face must be limited to a number of narrow faces—preferably not over 20-ft. long. These "fingers" of earth-surrounded refuse form individual cells in which the organic matter undergoes a fermentation caused

by the thermogenic organisms present in the organic matter. The temperature of the mass rises rapidly, stays at a high point for 10 to 30 days and then gradually falls. A peak of 150 deg. F. is aimed for. Usually six to twelve months elapse before the refuse becomes stable.

In adapting this process to American refuse, consideration should be given to the radical difference in material and the high cost of American labor.

The separation and incineration process means broadly the removal of fine dust by screening and the incineration of the tailings. Separation, however, can be carried further to include salvage of articles of some value. The fine dust (below ¾-in.) in London refuse runs as high as 28 per cent of the total in winter, frequently has a high moisture content and low calorific value. Some times it is used on heavy land, where its physical effect is useful, and for filling low land. Large quantities are used in making the "London stock brick." Perhaps the chief value of separation is in reducing the capacity required in the subsequent incineration equipment.

### Power from refuse

To one who has followed English incineration experience for a number of years, the most interesting part of Mr. Dawes' paper is his discussion of generation of steam and electricity. He states "the promise of a substantial income from steam supplied to the electricity department has not materialized in all cases and the time has arrived when electrical engineers in charge of municipal electricity works are lukewarm about combined refuse disposal and generation plants. They hold that the difficulties associated with joint plants often outweigh the advantages and generally they have good grounds for this attitude." In some cases, however, steam is still sold for electricity generation, for use in industry, for sewage pumping and for heating the water in public baths. The present average price is about one shilling (25c.) per 1,000 lb. of steam. The big Glasgow incinerator dealing with 750 tons of refuse per day produces 300 units of electricity per ton of refuse or 225,000 units per 24 hours. The selling price "does not exceed 0.3d (6c.) per unit."

The pulverization process consists of putting the entire refuse except metals through a hammermill crusher and the ultimate use of the material on farming land. Perhaps its agricultural value is more physical than chemical although it is said to possess a low fertilizing value. The cost of pulverizing is said to be about $1.00 per ton to which must be added transportation to farms. While the Ministry of Agriculture issued a circular favorable to pulverized refuse some time ago, there is little demand for it.

Disposal into the sea is now practiced by only six towns, although formerly there were more using this method. Dumping is permitted in one case at a point 3 miles out but in the other cases about 20 miles out. The depth of water must be 40 fathoms (240 ft.). The principal objection is the return of floating refuse to shore, but other troubles are inability to go to sea in stormy weather with consequent nuisance at the dock, and inability in calm weather to discharge refuse through hopper gates in the bottom of the vessel.

### Refuse disposal in Italy

In his paper on utilization of refuse in Italy, G. Rodella points out that in certain epidemics of contagious disease in cities, there have been no outbreaks in the suburbs in which the refuse of the cities had been disposed of by use in agriculture. He then furnished some statistics concerning composition and calorific value of Italian refuse.

In parts of Italy where the soil contains much clay and lime and where there is little livestock there is some demand among farmers for city refuse both as a fertilizer and as a means of giving warmth to the soil (by fermentation) for early crops and in greenhouses.

He refers also to several methods which apparently have been tried only on an experimental scale. Among these is the patented process of Prof. Lo Monaco for improving the refuse for agricultural purposes by incineration and impregnation of the residue with chlorine—said, by the inventor, to enhance the growth of plants.

Dr. Rodella lists about a dozen cities which use the Becarri process of fermentation. As practiced in Italy, the cells are generally 2.5 by 3.5 m. arranged on the interior so that air circulates throughout the mass. The temperature of the refuse charged is about 25 deg. C., after 5 days it reaches 40 deg. C. and after 25 days 75 to 80 deg. C. Fermentation continues about 35 days. The value of the resultant humus is greater if it has been soaked with "liquid manure" before closing the cell. An average analysis is:

| | Per Cent |
|---|---|
| Nitrogen | 1.02 |
| Phosphoric anhydrite | 0.29 |
| Potassium | 0.72 |

There are two Grasselli methods of fermentation, one of simple fermentation in the open, lasting about 5 minutes, with activity increased by controlling the moisture by wetting with water and by drainage; the other is perhaps really an adaptation of the Becarri method in which the refuse is moistened with "dung water" before closing the cell and the air is drawn out from the bottom by a vacuum pump.

In Reggio Calabria (pop. 60,000) there is a fermentation plant using "Boggiano Pico" towers—really a modification of the Becarri process. In these towers an attempt is made to hasten the Becarri fermentation by blowing air into all parts of the tow[illegible] after an initial period of anaerobic f[illegible] mentation lasting 8 days.

In Genoa (620,000 pop.) Milan (1,00[illegible] 000 pop.) and in several smaller cit[illegible] plants are in use for preparing refu[illegible] for agricultural use by crushing. [illegible] this way, the material becomes mo[illegible] homogeneous; the decomposition is d[illegible] layed for a few days (3 to 5) whi[illegible] permits transport to the farms before th[illegible] heating value is lost; odor is said to [illegible] changed from that characteristic of re[illegible] use to a stable odor; and the moistur[illegible] penetrates through the mass thus elim[illegible] nating the dust. Larvae of flies hav[illegible] never been found in storage heaps of th[illegible] crushed refuse. In storage heaps th[illegible] temperature rises quickly to 50 to 60 deg. C. while the outside air varies between 4 and 12 deg. C. Experiments show that when stored in heaps the greatest temperature is found at 30 cm. below the surface. B. coli in sealed glass tubes inserted in the heaps at about 50 cm. have proved sterile with few exceptions after 24 hours, and completely sterile after 48 hours, while controls at atmospheric temperature were still alive at 10 days.

Incineration is reappearing in Italy. Twenty-five years ago, people had hopes of utilizing heat from incineration of refuse and some plants were built for this purpose, but closed down when it was discovered that much additional fuel was needed to burn the refuse and the heat produced was neither constant nor great. Dr. Rodella adds that towns without considerable gardens and fields nearby will have to adopt incineration sooner or later—after they have realized "how important the disposal of refuse is all the year round."

### Vehicle display

One day of the congress was given over to the demonstration of vehicles in which the vehicles passed in review before a grandstand with a short demonstration and broadcasts of their characteristics in English, German and French. While the equipment was all for public cleansing, perhaps its most interesting feature was the fuel used which included wood gas and charcoal gas generated in retorts on the vehicle, compressed methane and propane.

As in all international congresses much time was lost due to the necessary translations of introductions, abstracts and discussions. In planning another international congress, it would be of great value to insist that all papers prepared be presented a sufficiently long time before the conference in order that preprints can be prepared and delivered to all delegates before their departure from their own countries. In this way an opportunity is provided for reading the papers and participating in the discussion. Unfortunately at Frankfurt the papers were not available until the meeting began and the discussion lost much value on this account.

# Tennessee Valley Authority Adopts Labor Relations Policy

**Comprehensive program in which employees have the right to organize for collective bargaining is established by TVA in statement of policy and by provisions for administration**

THE Tennessee Valley Authority, which probably employs directly more construction labor than any other organization in the country, has established a comprehensive labor relations policy, effective Aug. 28, 1935. Employees are to have the right to organize and to select representatives of their own choosing for the purposes of collective bargaining and employee-management cooperation. Membership in employee associations will be entirely voluntary, and no employee is to suffer discrimination because of membership or non-membership in any such organization.

In announcing the policy the board of directors of TVA recognizes that the Authority is an agency of the United States government, and as such the employee relationship of the Authority must conform to national policy, and the federal government must be in final control. Subject to these conditions, TVA has established governing principles upon which a progressive program of employee relations may be based. The policy, as it is now formulated, is regarded as an initial effort only, and is subject to growth and change in the light of experience.

The Authority will support as favorable labor standards and employment conditions as are consistent with the national welfare. The labor relations policy will find detailed expression in specific rules and regulations governing labor standards, rates of pay, classification, hours of work and employment conditions, as well as in memoranda of understanding.

The statement of policy follows in full:

## *The Policy in Detail*

1 An obligation rests upon every member of the management and supervisory staff, as well as upon each supervised employee of the Tennessee Valley Authority, to render honest, efficient and economical service in the performance of his duties. Organizations and associations of supervised employees and of the supervisory and management staff are likewise subject to this obligation.

2 Members of the management and supervisory staff and the supervised employees of the Tennessee Valley Authority together comprise an organization for public service. The wholehearted cooperation of all members of the organization in carrying out this Policy and the Tennessee Valley Authority Act is essential to attain the objectives of the Authority.

3 For the purposes of collective bargaining and employee-management cooperation, employees of the Authority shall have the right to organize and designate representatives of their own choosing. In the exercise of this right they shall be free from any and all restraint, interference, or coercion on the part of the management and supervisory staff. This paragraph shall not be construed to limit the rights of employees to organize for other lawful purposes.

4 No employee of the Authority and no one seeking employment shall be required as a condition of employment, transfer, promotion, or retention in service to join or to refrain from joining any organization or association of employees.

5 There shall be no discrimination against representatives of employees of the Authority nor shall employees suffer discrimination because of membership or non-membership in any organization or association of employees.

### Majority selects representatives

6 The majority of the employees as a whole, or of any professional group, or craft, or other appropriate unit, shall have the right to determine the organization, person or persons who shall represent the employees as a whole, or any such professional group, or craft, or unit. If a dispute shall arise among employees as to who are the duly authorized representatives of the employees involved, the Personnel Division of the Authority, which shall include a labor relations staff, shall investigate such a dispute and attempt to adjust it on its merits. In the adjustment of such a dispute the Personnel Division may, if the parties agree in writing, conduct an election to determine the duly authorized representatives of the employees involved. In the conduct of such an election the Personnel Division shall designate the persons who may participate. Should the Personnel Division be unable to adjust the dispute either party shall be free to invoke the services of the National Labor Relations Board.

7 Disputes between an employee and the management growing out of grievances or out of the interpretation or application of the published rules and regulations of the Authority governing labor standards, rates of pay, classification, hours of work, employment conditions, and the like, shall be handled by the employee or his representative through established supervisory channels, up to and including the designated chief supervisory officer concerned, as defined from time to time by the proper administrative officers. Failing prompt and satisfactory adjustment, the employee or his representative may appeal the dispute to the central office of the Personnel Division for investigation and adjustment.

8 Hourly and annual rates of pay shall be determined on the basis of occupational classification to assure comparable rates for comparable work. Schedules of such rates shall be published and made available to all employees. The division of occupations into classes of work shall give due and adequate recognition to intelligence, skill, training, and experience. The classification of occupations into classes and grades of work need not be bound by traditional rules and customs. The allocation of jobs or positions to scheduled grades shall be upon the basis of the duties to be performed. In the classification of annually rated positions due regard will be given to standards of classification and rates of pay prevailing in the classified federal service. No discrimination in occupational classi-

fication or in rates of pay shall be made on the basis of sex or race.

**9** The regular hours of employment of all hourly rated employees shall be bulletined by kinds of employment or by services at each place of employment. Such bulletins shall indicate how these hours may be worked in any twenty-four hour period. One, two, three, or four shifts may be worked on any kind of employment or service at each place of employment. The regular hours of employment shall not exceed eight in any twenty-four hour period. All work of hourly rated employees shall be so organized as to provide at least one day's rest in seven. Whenever feasible such day of rest shall be Sunday. All authorized overtime worked in excess of eight hours in any one working day shall be paid for at the rate of time and one-half. Any hourly rated employee required to work on Memorial Day, Fourth of July, Labor Day, Thanksgiving Day, Christmas, or on his designated day of rest, shall be paid at the rate of time and one-half. The supervisory and management staff and the supervised employees are expected, as a matter of good management and efficiency, to make every possible effort to minimize overtime and to conform to the schedule of bulletined hours. Failure to obtain reasonable compliance with the schedule of bulletined hours to assure elimination of excessive overtime will be interpreted by the Board of Directors as indicative of inefficient supervision and workmanship.

**10** The regular hours of employment of all annually rated employees shall be bulletined by kinds of employment or by services at each place of employment. The regular hours of employment shall not exceed eight in any twenty-four hour period. All work of annually rated employees shall be so organized as to provide at least one day's rest in seven. Whenever possible such day of rest shall be Sunday. All authorized overtime worked either before or after regular bulletined hours shall be recorded and accumulated as earned annual leave, to be taken in accordance with the regulations governing annual leave. Any annually rated employee required to work on Memorial Day, Fourth of July, Labor Day, Thanksgiving Day, Christmas, or on his designated day of rest, shall be allowed to accumulate such time as earned annual leave to be taken in accordance with the regulations governing annual leave.

**11** During periods of marked unemployment, hours of work will be kept as few as consistent with efficiency in production and reasonable minimum income.

**12** The desirability of giving advance notice before reducing forces is recognized.

**13** Appointments to the service of the Authority will be made on the basis of merit and efficiency as determined by such factors as intelligence, ability, skill, training, and experience. Promotion, demotion, transfer, retention in, or termination of, service with the Authority will be made on the basis of merit and efficiency, having due regard for length of service. No test of political belief or affiliation will be required of any employee or considered in his appointment, promotion, demotion, transfer, retention in, or termination of, service with the Authority. If an employee, who is doing the best work he can in good spirit, is found to be unsuited for the tasks to which he is assigned, an earnest effort shall be made to place him at other work for which he is better suited. Because it is in accordance with sound public policy that all work shall be done by those who can and will do it best, it shall be the policy of the Tennessee Valley Authority to add to its staff those who will distinctly raise its standards of work, and to offer equal opportunities for raising standards to employees already in the service. Employment in a position is not a vested right to be retained primarily because of possession, but only if quality of service justifies continuance of employment.

**14** No person under sixteen years of age shall be employed by the Authority. No person under eighteen years of age shall be employed by the Authority in a hazardous occupation.

**15** Appointments to the service will not be made when such appointments involve nepotism as defined by the Board of Directors of the Authority.

**16** Supervisors may, for just cause, terminate the service of any employee under their supervision, and such termination shall separate the employee from pay status. In so doing, the supervisor shall state the cause for termination in writing. A copy of the written notice stating such cause shall be sent to the Personnel Division and to the employee upon request. No employee shall be discharged from the Authority, however, without the approval of the Personnel Division subsequent to a fair hearing if requested by the employee or his representative within ten days of the effective date of termination.

**17** Adequate personnel and service records shall be kept for every employee in order that recorded data may serve as a basis for appraisal of merit and efficiency.

**18** The Authority will endeavor to make adequate provision for the safety and health of employees at their places of employment. The management and supervisory staff will endeavor to place employees in such tasks as fall within the limits of their physical powers, so far as these can be reasonably ascertained.

**19** In accordance with Section 3 of the Act creating the Authority not less than the rate of wages for work of a similar nature prevailing in the vicinity shall be paid to laborers and mechanics. In the event any question arises as to what are the prevailing rates of wages, which question cannot be settled by conference between the duly authorized representatives of the employees and the Authority, it shall be referred to the Secretary of Labor for determination, and the decision of the Secretary shall be final. In the determination of such prevailing rate or rates, due regard shall be given to those rates which have been secured through collective argreement by representatives of employers and employees.

**20** All contracts to which the Authority is a party and which require the employment of laborers and mechanics in the construction, alteration, maintenance, or repair of buildings, dams, locks, or other projects shall contain a provision that not less than the prevailing rate of wages for work of a similar nature prevailing in the vicinity, shall be paid to such laborers or mechanics.

**21** Schedules of rates of pay, whether hourly or annual, shall be published and remain in force and effect until revised or modified as provided herein. Schedules in effect will be open for revision not more often than once each calendar year. Proposed revisions will be investigated and studied by the Personnel Division in conference with supervisors and employees or their duly authorized representatives. Any requests for revisions of established rates of pay submitted during the year and not later than November 1, will be considered and acted upon by the Board of Directors of the Authority before the end of the calendar year. Published schedules of rates of pay shall designate the minimum rate for hourly employees and the minimum rate for annual employees below which no occupation will be classified. Provision may be made for special rates of pay for partially disabled persons or for intermittent service.

**22** Rules and regulations defining labor standards and conditions of employment, generally applicable to the employees of the Authority, other than rates of pay and occupational classifications, will be adopted, modified, or amended from time to time and thereupon published. At least 30 days published notice shall be given of any proposed new rule or change in established rules. No new rule may be adopted or existing rule changed until the duly authorized representatives of employees have had reasonable opportunity to confer with the supervisory staff and the Personnel Division.

### Concluding statement

As a further development of this Policy the Board of Directors looks for

ward to the establishment of joint conferences between the duly authorized representatives of the supervised employees and the supervisory and management staff for the purpose of systematic employee-management cooperation. The Board recognizes that responsible organizations and associations of employees are helpful to such cooperation. It is suggested that such joint cooperative conferences might well devote themselves to furthering the objectives for which the Tennessee Valley Authority was created. In so doing these conferences might consider such matters as the elimination of waste in construction and production; the conservation of materials, supplies, and energy; the improvement in quality of workmanship and services; the promotion of education and training; the correction of conditions making for grievances and misunderstandings; the encouragement of courtesy in the relations of employees with the public; the safeguarding of health; the prevention of hazards to life and property; the betterment of employment conditions; and the strengthening of the morale of the service. In the achievement of these objectives, it will not be desirable for these cooperative conferences to attempt to adjust individual disputes either among employees or between the employees and their supervisors, it being the intent of this Policy to adjust these matters promptly as elsewhere provided. When the other features of this Policy are satisfactorily translated into practice, the Board will stand ready to consider plans prepared jointly by supervised employees and the management by means of which these joint conferences may be established.

# High-Speed Tunnel Driving in Soft Material at Pasadena

## Heading advance through sand and gravel exceeds 2,000 ft. per month in 13-ft. aqueduct distribution tunnel

THE Pasadena tunnel is part of a 150-mile distribution system being built by the Metropolitan Water District of Southern California to deliver to member cities water brought through the Colorado River aqueduct. Entirely within the city of Pasadena, the tunnel is 12,000 ft. long and extends easterly from an access portal in Arroyo Seco near Pasadena's celebrated Rose Bowl; the greater portion of the bore is under Mountain St., one of the city's east-west thoroughfares. The cover ranges from 30 to 80 ft. Work at Arroyo Seco portal began Feb. 21 last, and such rapid progress has been made, despite the frequent changes of crews necessitated by the 30-hour week limitation that, by the middle of August, 73 per cent of the total length of the tunnel had been driven.

FIG. 1—ADVANCING the heading in the Pasadena water tunnel.

Five separate crews, averaging 20 men each, were organized and each crew works four 7½-hour shifts per week—a total working time of 150 hours in each 7-day period. Progress for May, June and July was 1,328, 1,795 and 2,002 ft. respectively; for the 31-day period from July 16 to Aug. 15 inclusive the total progress was 2,106 ft. By shifts the averages for May, June and July were 14.9, 21.1 and 23.3 ft. respectively. The average per shift for the total length driven to Aug. 15 was 17.3 ft. An average daily progress of 80 ft. was made from July 22 to July 27 inclusive, with a maximum of 93 ft. on July 22.

The engineers in charge modestly ascribe this remarkable progress chiefly to the favorable conditions encountered. The tunnel crosses an alluvial fan or ancient delta cone which was deposited in a series of irregular layers by a long succession of flash floods. These layers vary in thickness and in character of material, but in general they consist of a damp, partly cemented and well-com-

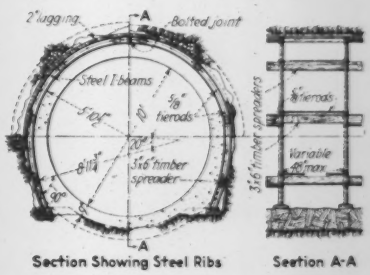



FIG. 2—CROSS-SECTION of Pasadena tunnel, showing general dimensions and details of steel ribs.

pacted alluvium, mainly sand and gravel with some clay lenses and a few boulders up to 10 or 15 in. in diameter. This material is easily excavated without the use of powder and usually stands well with a small amount of lagging behind the steel ribs used for temporary support.

The tunnel section is circular in shape, and to give the desired diameter of 10 ft. inside the lining the excavated section is made 13 ft. 3 in. wide at the spring line. The design provides for a reinforced-concrete lining, to withstand a maximum hydraulic head of 100 ft. The minimum lining thickness is 10½ in. in walls and arch and 9 in. in the invert. Specifications require that temporary supports consist of steel ribs, usually 4 ft. apart, with timber lagging. Each steel rib comprises two lengths of 5-in. 10-lb. I-beams pre-rolled to fit the

tunnel section and bolted together at the crown of the arch.

The full-face method of advancing the heading has been followed. The normal procedure after placing a steel rib is to drive by hand 2x10-in. poling boards 9 to 10 ft. long over the crown of the arch as a means of supporting the tunnel roof for a few feet ahead. The poling boards are inclined away from the tunnel section at a sufficient angle to provide space for the next steel rib. In the tighter formation ten or twelve poling boards are sufficient, while in the looser material it often has been necessary to continue them around the arch down as far as the spring line.

The face of the tunnel is next broken down with pneumatic spaders, and the loose material is loaded into cars by a mucking machine. Muck is hauled from the tunnel in cars specially designed to fit the tunnel section. The cars have a capacity of 5½ cu.yd. and operate on 24-in. track. Six-ton battery locomotives are used for hauling the muck trains, which dump into 250-yd. storage bunkers at the portal. From the bunkers the discharge is by gravity into trucks.

Switching of cars at the mucking machine is accomplished with minimum delay by the use of a California jump switch, a portable combination of siding and switch superimposed on the main track leading to the face. As used in this tunnel, the switch is 90 ft. long and can accommodate eight empty cars on one track, leaving the other track open for loaded cars.

F. E. Weymouth is general manager and chief engineer of the Metropolitan Water District of Southern California. R. B. Diemer is distribution engineer, and G. E. Baker is resident engineer on the Pasadena tunnel. The contract for driving this tunnel is being carried out by L. E. Dixon Co., Bent Bros., Inc., and Johnson, Inc., of Los Angeles, for whom H. J. King is general superintendent and D. L. Simpson superintendent.

# Developing Well Water Sources at Tacoma, Wash.

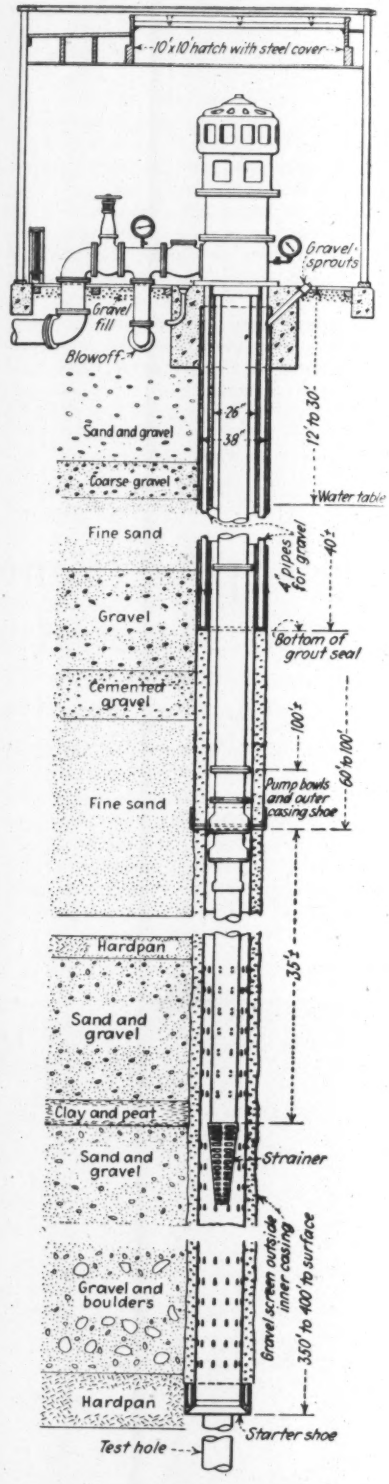
**Delivery of 9 m.g.d. from one well with a maximum drawdown of 60 ft. is typical supply capacity—Driving and perforating casings**

WHEN it became desirable a few years ago to supplement the gravity water system supplying the city of Tacoma, Wash., five large wells were driven in the south Tacoma district, tapping an underground gravel-filled basin. This has proven to be a highly satisfactory source yielding a pure and dependable supply at low cost. The advantages, on the whole, of having a water source so close to the distribution reservoirs have been such that new wells have been added as required and additional wells are contemplated when the industrial demand for more water increases. A standard plan has been developed for driving operations in putting down large wells, of which a typical installation is shown in the accompanying drawing.

When the location for a new well has been selected the first operation is to erect at the site a heavy timber frame box. This is loaded with gravel to provide a weight against which the jacks can be anchored when forcing down the casing. Snubber cables attached to a starter shoe guide the casing while it is being jacked down and they are operated to maintain the casing in a plumb position. Under this plan it is possible to control alignment of the casing at all times. Most of the formation is sand, gravel, clay or shale in which the ordinary bottom-trap bucket or "mud scow" is all that is required for removing material from inside the casing. However, various drilling methods are required on occasion and special rock tools have been used in some instances to cut through large boulders and hardpan.

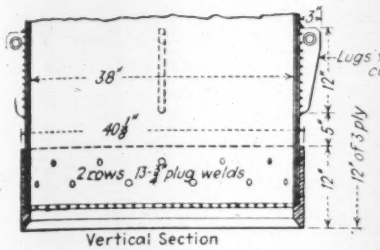
A small test hole put down in advance of the well casing usually gives the information necessary to decide upon methods, relative length of inner and outer casing and the maximum depth to which the inner casing should be driven.

Ordinarily the start is made with a 38-in. casing which is put down 60 to 100 ft. This is the outer shell and it always is carried deep enough to pass through the zones where surface water or water from other undesirable sources might find access to the well. The inner casing, usually 26 in. in diameter, is jacked down without guide cables because the outer casing already in place is made to serve as a guide by means of spacer blocks between the inner and outer casings. Gravel, carefully graded to uniform size between ½ and 1 in. in diameter, is put down behind the large starter shoe of the inner casing as it advances, and thus the space between the inner casing and the side walls of the well is filled with gravel. This prevents caving in of the walls in the lower portions of the well.



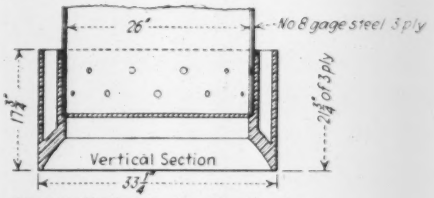

**SECTION of typical large-capacity well driven by city of Tacoma, to supplement its gravity water supply.**

The final operation on the inner casing is making perforations in the zones from which it is desired to collect water.

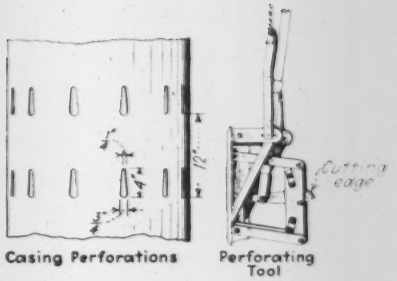



Detail of Outer Casing Starter Shoe

DETAILS of outer and inner casings for Tacoma wells and of perforating tool.




Detail of Inner Casing Starter Shoe




Casing Perforations — Perforating Tool

This is done with a simple cutting tool lowered inside the inner casing. Each perforation is made separately by thrusting down on the steel rod while tension is maintained on the suspension cable.

While the starter shoe is being driven, the gravel is merely dumped in between the casings. When driving is finished and soundings indicate that gravel has filled the space between casings up to the desired elevation, 4-in. gravel pipes are inserted between inner and outer casings, each one provided with a convenient means of access and fitted with a cap. The upper 40 ft. of the annular space between the inner and outer casings is then sealed with cement grout. From time to time the depth of the gravel is measured (by a sounding line and weight put down inside the 4-in. pipes) and such additional gravel as may be necessary is put in. This addition of gravel is considered "maintenance" and usually is the only attention which a good well requires once it is properly located and its inner casing is perforated to tap an underground gravel-filled basin through which water is percolating.

In the vicinity of Tacoma are very large glacial deposits, mostly gravel, extending well up toward the Cascade Mountains and affording convenient paths for underground percolation. Where wells are sunk into underground gravel basins of considerable size in such formations as found near Tacoma it is believed that the supply is "practically inexhaustible"; a reasonable limitation, of course, is that the wells should be staggered and not located too closely together.

Among the group of large wells which Tacoma uses (having inner casings 26 in. in diameter driven as described in the foregoing) one has a capacity of 9 m.g.d. with a maximum drawdown of 60 ft. When no water is being withdrawn from the wells the water level stands 12 to 30 ft. below the surface: this is in a location where ground surface elevations are about 285 ft. above sea level. Experience with these wells is taken to indicate that they tap a supply of tremendous capacity.

Data in the foregoing was obtained from W. A. Kunigk, superintendent, water division, Tacoma, Wash.

# Varied Character of Foundation Rock Delays Work on Red Bluff Dam

WORK on the combined hydroelectric and irrigation project which has the Red Bluff Dam on the Pecos River in Texas, 8 miles below the New Mexico state line, as its principal structure, has been held back by reason of the erratic character of the foundation as revealed after excavation of the core trench at the dam was begun.

From 3,500 to 4,000 ft. of core drilling was done on the foundation, and some 60 open test pits were dug, but even with this unusual amount of exploration the changes in material between test pits and core holes have been numerous and have required more preparation expense than was originally expected. A cutoff trench has been excavated the full length of the dam, and in many places this excavation has been necessary to a depth in excess of 50 ft., to cut off underground porous and gypsum strata.

This project is being built to store 300,000 acre-ft. of flood waters for the irrigation of Texas lands originally watered from the direct flow of the Pecos River, which had a minimum flow of 400 sec.-ft. in the nineties when large irrigation development in New Mexico and Texas took place. Irrigation in New Mexico cut the flow for the Texas projects, leaving only seepage and return waters with high alkali content as a normal flow. The Texas farmers thus had insufficient water to irrigate the land which they had in cultivation fifteen to twenty years ago.

Release of water during the irrigation season to these old projects and during the non-irrigation season to fill two existing reservoirs, built by two of the lower irrigation projects, will supply water the year around for a hydro-electric plant containing two units of 1,200 and 1,600 hp. capacity. The mean output is estimated at 1,500 hp., or 1,000,000 kw.-hr. net yearly production.

The reservoir will also control floods which in the past have done considerable crop damage.

The dam is to be semi-hydraulic earthfill, 9,150 ft. long. Other dimensions are as follows: height above riverbed, 104 ft.; maximum width of base, 555 ft.; width of crown, 30 ft. Quantities involved are 2,000,000 cu. yd. of earth, 200,000 cu.yd. of rock riprap, 15,000 cu.ft. of concrete, 22,000 sq.ft. of steel sheetpiles, 250 tons of reinforcing steel and 300 tons of fabricated iron and steel.

The reservoir, which will store 300,000 acre-ft., has an area of line encompassing 11,500 acres. The drainage area is 22,500 sq.miles. The area to be irrigated is 40,000 acres through water released and again diverted by seven independent irrigation systems.

The project was 28 per cent completed Aug. 1, and as most of the slow work in the preparation of the foundation has been completed, fast progress is now expected, with the completion date set for the fall of 1936. The Red Bluff Water Power Control District is being financed by PWA funds. Vernon L. Sullivan is engineer.

## Rhode Island Soil-Erosion Survey Planned

The Rhode Island State Division of Harbors and Rivers has announced a forthcoming survey of the shoreline of that state, to determine necessary steps against soil erosion and flood conditions along the coast. As soon as the two new state piers in Point Judith Harbor are formally turned over to the commonwealth, steps will be taken to correct soil-erosion conditions in the salt ponds between Narragansett Pier and Watch Hill. A study is now being made with a view to eventual construction of breakwaters and bulkheads along the shoreline.

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October 10, 1935


## *For Better Labor Relations*

FOR THE FIRST TIME in construction history a comprehensive labor policy that gives all workers a voice in management-employee relations has been established by a large employer. Except for the small proportion belonging to trade unions, the vast army of construction labor has had little chance to express the workers' viewpoint on working conditions. By establishing a labor relations policy the Tennessee Valley Authority now gives the worker that chance. As detailed elsewhere in this issue, the policy is frankly an experiment, and opportunity for change, revision and expansion is therefore provided. The experiment will succeed only if the workers make their selfish viewpoint secondary to the broader interests of the job as a whole. The TVA policy, while primarily an acknowledgment of the employer's obligation, point unmistakably also to the employees' obligation to make better relations possible; the suggestions for joint employee-management conferences to consider elimination of waste in construction, conservation of materials and energy and the improvement of quality of workmanship are significant, and hint at the possibility of making the policy more than a mere wage-bargaining agreement.

## *Confusion About Silicosis*

AT THE PRESENT WRITING, forty days after going into effect, New York's occupational-disease compensation law is surrounded by a dense fog of confusion and uncertainty. Silicosis or pneumonoconiosis, in simpler words the dust disease, is made a compensable disease by the new law; and as but little is known about the causation or cure of the disease—or even about its identification—the blanket terms of the law place the employer under heavy risk. All types of rock excavation are involved, as well as many manufacturing operations, such as iron founding and stonecutting. The state industrial commission, the official compensation rating board and the insurance companies are equally at sea as to how the law should be administered and what premium rates should be set. The man who must pay the bill, the plant owner or the contractor, is perplexed and bewildered as to which way to turn. He knows all too well that the law is in effect, for just now he is being forced to pay an arbitrary excess premium until more rational premium rates can be established. As to its ultimate application, however, he is still in ignorance. It is certain that it will breed lawsuits galore and bring up claims from old silicotic cases. As the case stands today the contractor's best defense is to take an active interest in dust prevention and to show his good faith by utilizing the best preventive and protective measures now available. New York's experience in getting the new compensation law under way is not surprising; any revolutionary change in occupational insurance may be expected to produce such results. Other states, whose legislatures may soon face demands for similar compensation laws, will profit by watching how New York struggles out of its perplexing situation.

## *A Significant Change*

WHAT MAY BE by far the most significant change in the relief-works set-up yet made is represented by the announced transfer of engineering supervision of WPA activities to the Corps of Engineers. For the present it indicates that at least in Washington engineers with knowledge of construction problems will have a voice in directing the relief-works operations. As to the situation outside Washington it is obvious that eleven army engineers scattered widely over the country can hardly be expected to give more than the most superficial supervision to the multitude of WPA operations in their districts. For example, Colonel Fleming, now located on the easterly tip of the country at Eastport, Me., in charge of the Passamaquoddy power project, is named as field engineer for the whole of New England, and Colonel Robins at Portland, Ore., has all of Washington, Oregon and Idaho under his charge on top of his responsibility for the Bonneville project and a large engineer division. If the change is to end with the naming of thirteen army engineers as engineering advisors to the WPA, it may only mark the preparation of the way for passing the buck to the army engineers for a possible breakdown of the WPA program.

## *Works Program Still Changing*

THOUGH WASHINGTON reported a week ago that the entire works program fund had been distributed it seems that the program is still subject to much other change, as indicated by the current week's report that a PWA grant of $9,000,000 has been made to Baltimore for water, sewer, building and other construction. This unexpected development may be coupled with another announcement—this from the WPA—to the effect that contractors for PWA projects may hire skilled labor from other sources than relief rolls if the rolls cannot supply enough of the needed labor. Together, the two pieces of news reveal once again that, although nine months' time has been available for working out procedure and policies of the works program, the planning has been so incomplete as to require important changes even now. Had the original policies and rulings been assigned to meet easily foreseeable contingencies, as experienced construction men repeatedly warned should be done, a far quicker and smoother start on the program would have been assured. As it is, the authorities are forced to admit that the program which was to go into full operation three months ago has so far put less than half of the full quota of men to work—and even this figure is in part a mere bookkeeping fiction, since it includes the men working on previously existing local relief projects, CCC enrollees and the like. The picture is disappointing. But a substantial part of the program can yet be salvaged if practical construction sense is effectively given charge.

## *Progress Toward Stream Protection*

THE SOLID AND WELL-CONSIDERED recommendations contained in the stream-pollution committee report summarized on another page clear the way for progressive action to deal with conditions that already are bad in many localities, are steadily growing worse, and in time would make every stream a noisome offense. Much has

been done to clean up and keep clean the streams contained within individual state areas, through the alertness and energy of state sanitary authorities. These same authorities in coooperation are also adequate to deal with interstate stream pollution, especially if the federal government joins in the cooperative group. The committee's plan, endorsed by the National Resources Committee, adopts this view. The recommendations are to be welcomed, for the occasion offered direct temptation to urge extension of federal jurisdiction to stream pollution in its entirety, a course that would surely weaken the efficient state agencies. In order that the elements of cooperation may soon be developed by experience with a concrete project and the details of appropriate legislation worked out, the suggested Potomac River demonstration should be initiated at the earliest moment. Not only are all forms of pollution present there, but the case has already had a good deal of study and the several agencies concerned are ready for joint action.

## Price Indexes in Valuation

A MAJORITY of the U. S. Supreme Court has condemned the application of general commodity indexes to a conglomerate of assets constituting the plant of a public utility in determining the value of that utility for rate-making purposes. This decision was reached in reviewing a lower-court finding in respect to a valuation placed on the property of the Chesapeake & Potomac Telephone Co. The decision, abstracted in this issue, was far from unanimous, three justices holding that the placing of a fair value at best is but an estimate and that the method adopted by the Maryland Public Service Commission is convenient and reasonably accurate.

Superficially, the Supreme Court here appears to reverse the position it took in the now famous St. Louis & O'Fallon R.R. valuation case, in which it threw out the Interstate Commerce Commission's value of the railroad's property on the ground that the commission had failed to take into consideration evidence of increased value over cost as revealed by changes in cost index numbers. But in fact the present decision is not a reversal of the earlier position; the finding then as now rests on the view that proper weight had not been given to *all elements* going into determination of value, of which price trend is but one.

The Maryland Commission based its findings almost exclusively on a group of well-known index numbers, to which it gave weights of its own choosing. That such a method may result in error is evident, especially if the period covered is long. For example, price indexes cannot reveal obsolescence; and over a long period of years obsolescence of plant or equipment may materially affect the value of a utility's property. On the other hand, a complete reappraisal of a utility's property is very costly in both time and money. So is the long legal battle that generally ensues as the appraisal is fought over item by item in court. Where the period covered is short, the possibility of other elements than price trend having an important bearing on the ultimate result is remote.

Careful reading of the Supreme Court's decision indicates that it does not rule out the use of cost and commodity index numbers in valuation work. How extensively they may be used remains to be learned by slow experience, for in this case as in others the court refrains from saying *how* the value should have been determined in order to meet with its approval.

That cost and commodity index numbers may hold a major position in future valuation work is revealed by the emphatic dissent of Justices Brandeis, Cardozo and Stone. The opinion of this group, containing as it does the two younger justices on a bench that divided six to three on this case, appears to indicate a pronounced trend in that direction. Even some statements in the majority opinion support this view. If this be so, future valuation cases may center around the reasonableness of the index numbers used rather than around the pricing of a multitude of items that now slows up almost all valuation proceedings.

## Serious Work Ahead

TO THE CITIZEN AT LARGE the wreck of the works program is a matter of keen regret over lost recovery opportunities and debasement of sound social principle. To public-works engineers and officials however, it brings in addition the realization of a weighty new responsibility, one that is bound to direct their immediate planning and exert a far-reaching influence on the future course of their public service. The present moment in fact marks the time of a new departure in our public-works history.

For nearly a year public-works authorities have done little other than exert themselves to make the relief-works program a success. Their every thought and effort was given to it. Their normal occupation of maintaining and renewing the equipment of community life had been suspended long before, as the compelling pressure of retrenchment and relief permitted little more than sporadic effort in maintaining and renewing the community's facilities, save for the emergency assistance of the federal government. Hence their strenuous labors in the PWA campaign of 1933 and 1934, and hence, also, their active response to the promise of Congress to devote nearly a billion dollars of the Relief Act money to local public-improvement construction as a means of creating employment.

That promise largely vanished when the works program was surrendered to the welfare group. Only a fraction of the promised public works found approval; for the rest the money that was to be converted into useful works is being spent for boondoggling, displacing normally employed workers by relief men, and thinly-veneered dole-dispensing. Now and in future the upkeep and improvement of the service plant of cities, counties and states will depend solely on their own planning and their own initiative. The day of PWA programs is over.

Now is the time, therefore, to return to normalcy in community planning and construction. Official and engineer have the duty of taking up again the regular care and development of public facilities, as the needs and ability of their community may require and in accordance with a planned long-time program and sound financial system.

And in this undertaking they have more to do than merely return to the practices of the past. Under the far more severe conditions of today and the future, haphazard improvement construction can no longer be satisfactory. The times clearly demand that a well-considered public-works policy be made the basis of community development. With the aid of such policy, a definite program, and the realization that each community must build on its own resources, public-works engineers will be prepared for the serious work that lies ahead of them.

# CURRENT NEWS

## Large PWA Allotment Made For Baltimore Program

The President has approved a grant of $9,000,000, recommended by PWA Administrator Ickes, to aid in financing the Baltimore PWA program. The Baltimore plan comprises 22 permanent municipal improvements estimated to cost $19,316,119.

In submitting its application for the entire program the city did not request a PWA loan, stating that it would be able to borrow the remainder of the required money in the private investment market. The $9,000,000 grant will be paid from the new relief works appropriation. Presidential approval of the grant was given in a letter authorizing the Secretary of the Treasury to transfer $9,000,000 from the relief works appropriation to the PWA.

The Baltimore plan comprises the following 22 projects:

To be constructed by the Bureau of Water Supply: Venturi meter, Montebello filter plants, $47,150; concrete roof over the Montebello filtered water reservoir, $222,850; 4,000,000 gal. steel storage tank at the Melvin Avenue reservoir, $91,850; 1,500 ft. of 30-in. main under Curtis Creek, $109,750; concrete pressure tunnel 12 ft. in diameter from Loch Raven Dam to Montebello filtration plant, $4,840,000.

To be constructed by the Bureau of Sewers: Tiffany Run intercepter sewer, 7,400 ft. long, $175,370; 14,500 ft. of sewers, Dukeland and Graceland avenues, $294,988; storm water drain from Janney and O'Donnell streets to Patapsco River, $245,212; two 25,000,000 gal. sewage settling tanks, Back River treatment plant, $254,635.

To be constructed by the Bureau of Public Improvements: Eastern High School, $1,433,000; Additions to Brehms Lane, Hampden, Howard Park and Highlandtown schools, $450,000; widening and paving Fayette Street, $977,048; widening and paving Forrest and Ensor Streets, $890,369; extending Howard Street, including underpass and viaduct, $2,328,669; laundry building for the City Hospital, $45,345; equipment in laundry building and steam supply for hospital, $105,000; wing for Art Museum, $508,650; bridge over Gwynns Falls Valley, $504,050; Colgate Creek Bridge, $504,050; 29th Street bridge over Jones Falls Valley, $631,700; outfall sewer, $4,156,433; sewage treatment works, Curtis Bay, $500,000.

## Central Valley Among Projects For Which Funds Were Cut

The original allotment of $20,000,000 which had been made for the work to be done in the first year on the Central Valley project in California was reduced to $15,000,000 when the total of allotments made to the Bureau of Reclamation was cut from $101,150,000 to $81,150,000 in the final shaping up of the relief works program. This reduction, which was the largest of all those made, was omitted from the account in last week's issue.

## Engineering Supervision of WPA Work Will Be Under Army Engineers

*(Washington Correspondence)*

PRACTICAL measures were taken by President Roosevelt this week which anticipate that the relief works program soon will be under way. Engineering supervision of WPA projects was placed in the hands of the Corps of Engineers of the army and the start of many PWA projects was facilitated by an order which finally discards the requirement that 90 per cent of all labor employed must be drawn from relief rolls.

In order to harmonize wage rates paid on projects financed under the original public works program and PWA's new program, Administrator Ickes, with the President's approval, rescinded the PWA minimum wage rates, established two years ago, on all projects on which contracts had not been let or advertisements approved prior to Oct. 9. On such projects, the same wage rates will apply as on PWA projects financed by grants from this year's $4,000,000,000 relief works appropriation. These rates will generally represent prevailing rates as cities and other political subdivisions receiving PWA grants must determine the rates "in accordance with local wage conditions" subject to approval by PWA state directors.

As forecast in *ENR*, Aug. 15, revision of a previous administrative order by Administrator Hopkins permits state administrators to waive the 90 per cent relief labor requirement on PWA projects where there are no qualified workers on relief rolls available within the vicinity of the project. The term within the vicinity is defined as an area within which the worker may travel to and from work without unusual expenditure of time or excessive cost of transportation.

### Preference to Union labor

A previous order giving preference to union labor on relief rolls, when requested by the contractor, has been extended to include union men not on relief rolls, when the relief roster of union members is exhausted. If the unions fail to certify qualified workers to the U. S. Employment Service within 48 hours (Sundays and holidays excepted) after a request has been filed by the contractor and the employment agency has notified the contractor of the receipt of the request, such labor may be chosen by the contractor from other qualified workers supplied by the employment agency.

Preferences applicable to union labor are subject to the requirement that the preponderance of labor shall be taken from bona fide residents of the political subdivision which is financing, in part, the construction of the project, and second, from the county in which the project is located, to the extent that labor technically qualified to perform the work is available.

Major General E. M. Markham, Chief of Engineers, U S. Army, has been designated by the President as engineering consultant of WPA, and Lieut. Col. F. C. Harrington, has been appointed chief engineer of WPA. Eleven engineer officers have been appointed consulting field engineers. The announcement by Administrator Hopkins is couched in terms which raise a question as to just how much authority over engineering matters remains in the hands of WPA state organizations, but it appears probable that the Army engineers will move in whenever and wherever state organizations fall down in technical performance.

WPA state administrators have been advised that the army engineers will shortly visit the areas to which they are assigned. President Roosevelt probably acted in the belief that detailing the services of engineer officers was a comprehensive and inexpensive method of insuring that the WPA program is given adequate engineering service.

The army engineers, and the areas to which they have been assigned, are:

Lieut. Col. P. B. Fleming, New England states; Lieut. Col. J. C. H. Lee, New York, New Jersey, Pennsylvania; Maj. W. F. Tompkins, Delaware, Virginia, Maryland, North Carolina, District of Columbia, South Carolina; Lieut. Col. Brehon B. Somervell, Tennessee, Mississippi, Georgia, Florida, Alabama; Maj. W. D. Styer, Ohio, Indiana, Kentucky, West Virginia; Lieut. Col. R. A. Wheeler, Michigan, Wisconsin, Illinois, Missouri; Capt. J. M. Young, North Dakota, South Dakota, Nebraska, Kansas, Minnesota, Iowa; Lieut. Col. David McCoach, Jr., Oklahoma, Arkansas, Texas, Louisiana; Capt. B. M. Harloe, Montana, Wyoming, Colorado, Utah, New Mexico; Col. T. M. Robins, Washington, Oregon, Idaho; Lieut. Col. Earl North, California, Nevada, Arizona.

***Washington, October 7, 1935.***

## Consulting Engineers Named for Florida Canal Project

The appointment of two engineers to act as consultants on the Florida cross-state canal was announced on Oct. 3 by the Corps of Engineers. H. H. Buckman, Jacksonville, Fla., and Malcolm Pirnie of New York, have been named to draw up reports on the economic and engineering aspects of the project. Mr. Buckman, who from 1923 to 1925 was consulting engineer for the city of Jacksonville, has also served as consulting engineer of the National Gulf-Atlantic Ship Canal Association. Mr. Pirnie in his capacity as a consulting engineer on water supply for Florida cities has made studies of the underground conditions that will facilitate a determination of the possible effect of the canal cut upon the artesian supplies of the state.

# New Trends in Sludge Disposal Discussed at Joint Sewage Association Meeting

A TECHNICAL SESSION devoted to current thought on sludge disposal methods and a fundamental review in B.O.D. determination followed by a sewage plant inspection tour in which a new sludge disintegrating machine and a vacuum filter were demonstrated, were highlights of the first joint meeting of the New York State and New England Sewage Works Associations held at Schenectady, N. Y. Oct. 4-5. Morris M. Cohn and Gordon M. Fair, presidents of the respective organizations, alternated as chairman throughout the meeting at which the attendance was about 325.

In a short business meeting of the New England association, the following officers were elected for the coming year; Guy E. Griffin, president; Stephen De M. Gage, vice-president; and F. W. Gilcreas, secretary-treasurer.

### Sludge disposal methods

Discussing the noteworthy advances that have been made in methods of sewage sludge disposal, which seemed in 1930 to be reaching a state of standardization, F. W. Mohlman, chief chemist of the Chicago sanitary district, stated that the most important development, in his opinion, was the adoption of odorless incineration as a means of disposal of undigested sewage solids. This has not only broadened the field of sewage disposal but has provided an alternative scheme in which digestion is not essential and thus simplified the process of sewage treatment.

The selection of flash drying and incineration at the new Southwest works in Chicago was described as the result of five years' extensive investigation covering numerous methods of disposal. This method was adopted because it (1) eliminated digestion, (2) made possible the disposal of solids on a comparatively small area as compared with the enormous sand beds required with digestion, (3) gave the most complete and most sanitary results, (4) made possible the use of a power plant, operating on incinerated sludge, for the production of power needed for the activated sludge process, and (5) was the most economical. On a number of screening tests on the sludge from the flash dryer it was determined that the product coarser than 40-mesh contained comparatively large amounts of straw, fibers and splinters all of which are low in fertilizer value but high in combustibility. It was suggested that this material and the dusty product passing the 100-mesh screen could be diverted to the furnaces while the intermediate screen fractions, rich in ammonia, could be segregated and sold for fertilizer.

Other advances that were outlined included two-stage digestion, thermophilic digestion, utilization of gas, return of digested sludge for seeding fresh solids and improvement of the design of digestion tanks. Vacuum filtration of sludge was stated to have been made more attractive by elutriation which has resulted in the reduction of the requirements of ferric chloride and in more rapid rates of filtration. Although filtration and dumping of filter cake on waste land has been recommended for several sewage treatment plants (Washington, Baltimore, New York and Columbus) the author felt that this was only a partial solution of the sludge problem and not as complete or desirable as incineration.

### B.O.D. determining

The biochemical oxygen demand (B.O.D.) test was termed one of the three tools available to the sanitarian in establishing a concept of pollution, by Prof. Earle B. Phelps, Columbia University. The others are: Enumeration of bacteria and the measurement of suspended solids.

Following the exponential law of decrease, the rate of reduction of B.O.D. through natural processes and at 20 deg. C. temperature was stated to be approximately 21 per cent per day ad infinitum. This rate of reduction is remarkably constant with all the different kinds of waste and mixtures of wastes. Factors which may modify this orderly change are: oxidation processes (trickling filters or activated sludge), temperature changes and application of chlorine.

The real interest in B.O.D. determination lies in its practical application for measuring how much and how fast sewage or other wastes will remove the dissolved oxygen content in a stream. From this information can be determined the effect of waste discharges and the required amount of treatment necessary to preserve an oxygen balance for the prevention of obnoxious conditions.

Other papers covered a detailed description of the cost accounting system used by the Worcester, Mass., sewer department presented by John H. Brooks, superintendent of sewers, and an outline of the principal design features of the new Walden, N. Y. (pop. 5,500) disposal plant by Newell L. Nussbaumer, consulting engineer, Buffalo. One of the unique features of the plant, which is located in a city park, is a dry-seal sludge-gas holder. Although several such holders have been installed by gas companies this is believed to be the first sewage plant installation.

### Sunrise breakfast

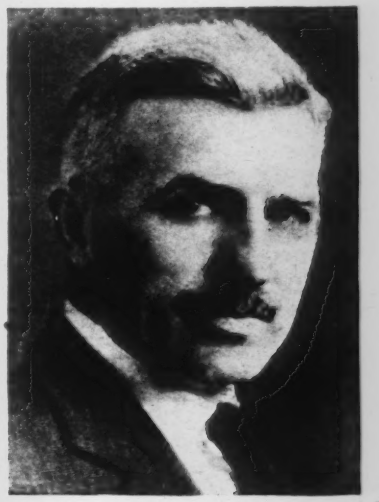
Following the custom established by the New York association several years ago, the members assembled at 7:30 A.M. on the last day of the convention for a "sunrise breakfast" followed by a round-table discussion conducted by C. C. Agar of Albany and S. E. Coburn of Boston.

## Resettlement Administration Plans Housing Program

The Resettlement Administration has scheduled a suburban housing program totaling $27,000,000 to date. Five projects have been planned that would provide 4,500 dwellings. Cincinnati heads the list with a $10,000,000 development comprising 1,500 houses. Oakland, Calif., and St. Louis are listed for $5,000,000 each in plans calling for construction of 1,000 houses.[1] Projects in Bound Brook, N. J., and Beltsville, Md., the Department of Agriculture research center near Washington, D. C., are contemplated for construction of 500 houses at a cost of $3,500,000 in each community.

## J. F. Cushing Dies in Air Crash, Prominent Dredging Contractor

John Francis Cushing, president of the Great Lakes Dredge & Dock Co., of Chicago, and the Hydraulic Dredging Co., of Oakland, Cal., was killed in the crash of an air liner near Cheyenne, Wyo., on Oct. 7. He was returning to his home in Evanston, Ill., from a business trip to the



John F. Cushing

West Coast. Mr. Cushing was born at Arapahoe, Neb., in 1882. He attended the University of Nebraska for a brief period and graduated as a civil engineer from Notre Dame University in 1906. Years later he donated a $300,000 engineering building to his alma mater.

Soon after his graduation, Mr. Cushing entered the employ of the Great Lakes Dredge and Dock Co. as a timekeeper and he never left this firm. After serving as timekeeper and field engineer, he was made a division engineer of the company in 1917, and in 1919 became assistant general manager. In 1922 he was appointed president, and in 1929 was named chairman of the board, holding both positions at the time of his death. During his presidency, the Great Lakes Co. was engaged in many notable construction projects, including the straightening of the South Branch of the Chicago River, the Ogden Ave. viaduct, Wacker Drive, Lincoln Park lake front fill, and the World's Fair grounds fill, all in Chicago, and widening and deepening of the Cape Cod Canal, construction of the Hocking Valley water terminal at Toledo, construction of the cellular breakwater at Calumet Harbor and Indiana Harbor, Ind., and scores of large dredging projects throughout the Great Lakes and Atlantic Seaboard regions.

Mr. Cushing was also a noted designer of dredging plant, and pioneered in the development of the diesel electric dredge. Under his direction the first large diesel electric dredge "Crest" was designed and built in 1926. This unit is equipped with a 16-yd. dipper, and is now working on the approach to Cade Cod Canal through Buzzards Bay. The "New Jersey," a 30-in. hydraulic dredge, diesel electric drive, was also designed under the direction of Mr. Cushing.

# Allotment Made For Continuing of National Parkway

PRESIDENT ROOSEVELT has approved an allotment of $6,000,000 from old PWA funds for additional construction on the Shenandoah-Great Smoky Mountains National Parkway. The work is to be started at once. A description of the proposed 400-mi. parkway appeared in *ENR* July 25, 1935, p. 112. Another allotment of $6,000,000 was made some time ago but most of it was diverted last winter for relief purposes.

The program in Virginia will include construction from Shenandoah National Park to Rock Fish Gap, adding a parkway extension to the present Skyline Drive, for ten miles to the Charlottesville-Waynesboro highway. The second section will start from Adney Gap, near Roanoke, and proceed toward the North Carolina line as far as funds will permit. Before actual construction is started, the state of Virginia must furnish a 200-ft. right of way and agree to secure authorization from the next Virginia legislature for the furnishing of wider rights of way, similar to those now being furnished by North Carolina.

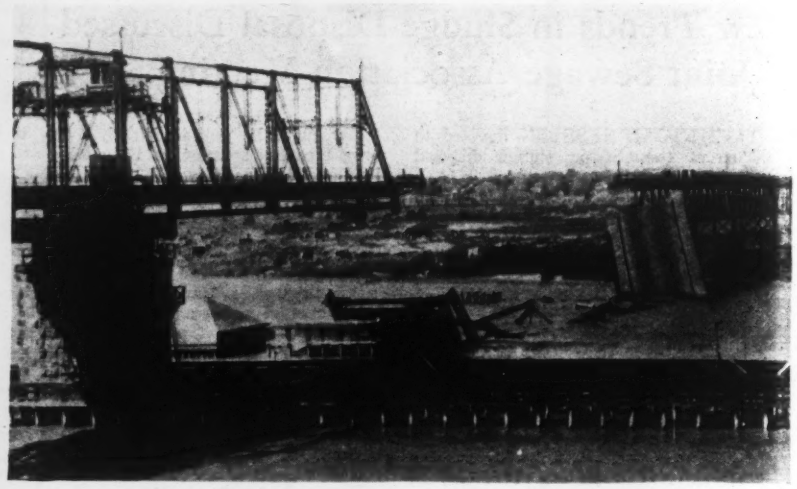
North Carolina's construction program will provide for construction from Roaring Gap to Air Bellows Gap, and on sections from Air Bellows Gap to Deep Gap, a distance of 42 mi., as fast as these projects can be put in shape for letting contracts; construction of the parkway from Soco Gap to Cherokee, if the Cherokee Indians will grant the required right of way through their reservation; also preparation of contract plans and specifications for the section between Buck Creek Gap and Bull Gap.

The program as outlined will provide sections of the parkway which will be usable units in themselves, besides serving as connections between existing highways or cities, and leading toward the completion of the continuous 400-mi. parkway connection between the proposed Shenandoah and Great Smoky Mountains National Parks.

## G. L. Berry Named Coordinator To Facilitate Trade Agreements

President Roosevelt has named George L. Berry, former divisional administrator of the National Industrial Recovery Administration, as Coordinator of Industrial Cooperation. The President's objectives in setting up this new office are, first, to expedite the approval of voluntary fair trade practice agreements incorporating, as a new feature, provisions limiting wages and hours; and, second, to develop through hearings at which management, labor and the consumer will express their views, the permanent machinery for elimination of cut-throat competition.

Mr. Berry knows both sides of the management-labor problem in industry because he represents both interests. He is a large employer both in his capacity as head of a publishing organization and as one of the most extensive farm operators in the southeast; he also is president of one bank and a director in another, and is president of the Printing Pressman's Union. He has served on the NRA Labor Advisory Board.



**TOLEDO BRIDGE SPANS COLLAPSE INTO MAUMEE RIVER**

**The failure on Sept. 30 of two spans of the 40-year-old Fassett St. Bridge over the Maumee River at Toledo, Ohio, is the subject of a current investigation instigated by George N. Schoonmaker, director of public service of the city. Shortridge Hardesty, consulting engineer, New York, is making the investigation. Until more data are available, the cause of the accident must be a matter of conjecture, but preliminary evidence points to failure of the pier between the two collapsed spans, which may have been weakened by adjacent dredging operations.**

**The spans involved in the failure are a 240-ft. through truss and a 130-ft. deck truss immediately west of the swing span over the navigation channel. These trusses, of pin-connected type, carried a 24-ft. timber floor and were supported on stone masonry piers founded on two- or three-layer timber grillages resting on timber piles. At the time the bridge was built these piles were cut off just above the river-bed, but subsequent dredging deepened the river 5 ft. or more at the various piers. No riprap was used around the pier bases. At the pier common to the two failed spans, which is out of sight and awaits inspection by divers, the grillages were probably 10 ft. above the riverbed as a result of this dredging. The accompanying view of the wreckage shows the remains of the two spans and also illustrates how the top six courses of masonry on the pier under the end of the swing span were knocked off by the through span as it fell.**

**Eyewitness accounts throw no light on the cause of the accident. A heavy truck had crossed the bridge just before it fell, but there were no vehicles on it at the time it collapsed. One of the bridge tenders was thrown into the river but escaped injury. The steelwork of the bridge is quite light, but examination is said to have revealed no evidence of weakness. The opinion seems to be that the collapse was caused by a foundation failure induced by dredging.**

# Contractor Must Go to Woods and Pits for Materials for Illinois River Lock

THE contractor who receives the award for the construction of a 110x600-ft. lock on the Illinois River near Peoria, Ill., for which bids will be opened by the Chicago District Engineer, U. S. Engineer Dept., on Oct. 22, will be required to take relief labor into the woods, gravel pits and quarries to obtain the piles, cribbing timber, aggregates and riprap required for the project. These unusual requirements are noted in a clause in the call for bids stating: "The contractor shall obtain all timber piling and crib timber directly from the forest; and all stone, gravel and sand for stone protection and concrete aggregates, directly from the quarry or pit. All material required in the construction of the esplanade and roadway (4,000-ft. gravel road) shall be excavated by hand-labor methods. All of the above work shall be executed strictly with forces engaged solely on operations under this contract and in accordance with the provisions of Par. 1-30." The paragraph referred to requires that 90 per cent of the labor force be obtained from relief rolls and specifies minimum wages for each class of labor.

Estimated quantities of items to which the above provisions apply are: 222,000 lin.ft., or about 7,000 piles, round timber piling, 30 to 35 ft. long; 261,000 f.b.m. cribbing timber; 5,840 cu.yd. derrick stone and riprap; 64,100 cu.yd. concrete; 108,000 cu.yd. roadway and esplanade fill; and 8,890 sq.yd. gravel road surfacing.

In answer to specific questions concerning the clause, the Chicago District Engineer Office wired *Engineering News-Record* the following information: The contractor must obtain timber and piling from the forest with forces engaged solely upon this contract, but may obtain these materials through a subcontractor provided the subcontractor's operations thereon apply solely to this contract and that the special wage and labor provisions are observed. The opinion is expressed that adequate timber is standing within a reasonable distance from the job to supply the piles, but to obtain the cribbing timber the contractor may have to go far afield. In such case, he need not take along Illinois relief labor, but may use relief labor from the vicinity of the timber stands, paying the minimum wages specified in the contract. In the opinion of the engineers there are sufficient undeveloped sand and gravel deposits and quarries in the vicinity to supply stone and aggregates. The contractor's forces must work the deposits.

## Truss Distortion Cause of Theatre Crash

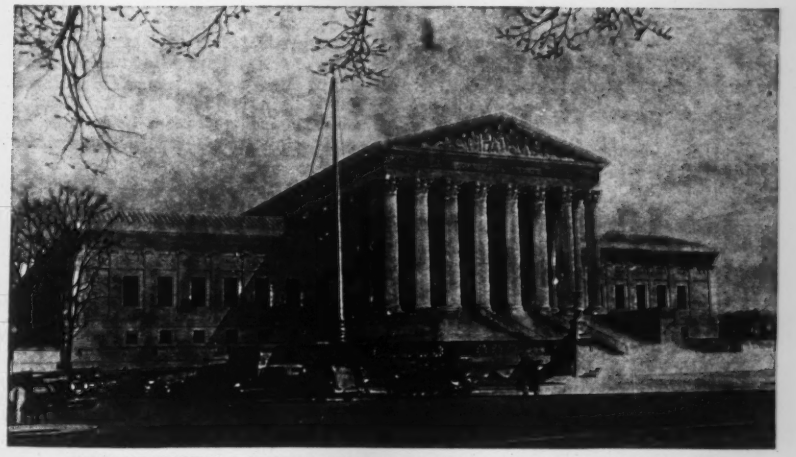
An investigation of the collapse, during demolition, of the roof of the celebrated Hollis Street Theatre at Boston, Mass., on Sept. 18, which caused the loss of two lives, has been completed by Edward W. Roemer, building commissioner of that city. The fundamental cause of the collapse, it is concluded, was the removal of the tongue and grooved wood sheathing upon which the roof trusses apparently relied for lateral stability. The collapsed portion of the roof measured 75x85 ft. in plan and involved ten trusses of 85 ft. span placed at 7½ ft. centers. They are described as compound Fink type and rested on masonry walls 45 ft. high. The top chords sloped up to a height of 72 ft. at the apex.

Examination of the wreckage reveals the trusses to have been of unusual design; web members consisting of T's, I's and flats, while iron castings were used for the wall bearings and the ridge joint. Recesses in the wall casting accommodated the top and bottom chords while the top chords and the two center web members ($2\frac{1}{2}$x$\frac{3}{8}$-in. bars) were inserted in the ridge casting. There was also a recess in the ridge casting to receive longitudinal bracing between the trusses but no such bracing members could be found in the wreckage.

The trusses while extremely light for their span and height had supported the roof for a number of years and apparently would have continued to support it in its undisturbed condition. But except for the plank sheathing there was no evidence of sway bracing or lateral ties of any kind between the several trusses. It was evident from an examination of the trusses that while they remained in alignment they would function to carry the superimposed load, but, removal of any considerable number of roof planks would allow the top chords to distort, placing an unusual strain on the cast-iron connections. It was evident that the south top chord of the truss next to the proscenium wall failed first. On account of the peculiar type of construction, the failure of any one truss would account for the collapse of the structure.

## Steel Sheetpiling at Ft. Peck Driven to Depth of 161 Ft.

Steel sheetpiling at the extreme western end of the Fort Peck dam cutoff wall was driven to a record depth of 161 ft. by the Frazier-Davis Const. Co., of St. Louis, Mo., contractor on the wall. The penetration exceeds the maximum of 155 ft. reached last fall in driving the wall across the flood plain, and is believed to be the record for this type of piling. The long sheets, made up of two lengths of piling, are being driven from a 200-ft. tower gantry traveling down the steep slope of the west abutment of the dam. A similar gantry is working up the slope, the two rigs slowly closing the last gap in the 9,000-ft. steel diaphragm driven to shale rock under the base of the huge earth fill. Pile driving in the west abutment is difficult, for the geologic formation is glacial fill containing coarse gravel and small boulders. The contractor attributes the success in driving through this material to the use of hydraulic spade jets, developed on the job (*ENR*, Aug. 29, 1935, p. 291).



**SUPREME COURT OCCUPIES ITS PARTHENON PALACE IN WASHINGTON**

The U. S. Supreme Court convened on Oct. 7 in its new building facing the Capitol grounds in Washington. Its architecture is Greek classical after the Parthenon. The new building is inclosed in 24,700 pieces of white Vermont marble. Each of the fluted Corinthian columns in the west facade is 6 ft. in diameter, 51½ ft. high and weighs 100 tons. A total of 455,000 cu.ft. of marble, believed to be more than in any other public building, was used in the building. The frame is structural steel and the roof of reinforced concrete sheathed in copper and covered with tile. Protection for the steel columns consists of three coats of paint, a covering of waterproofed concrete and finally an enclosure of tile.

In outside dimensions the building is 385x304 ft. The main hall is 164 ft. long, 40 ft. wide, lined on sides and ends by a total of 36 white marble columns. The Court chamber, seating 238 (about 10 per cent more than the old courtroom in the Capitol) is 82x91 ft. in plan.

The building was designed by the late Cass Gilbert, well known architect, and its construction supervised by David Lynn, architect of the Capitol and executive offices of the Supreme Court Building Commission. The contractor was the George A. Fuller Co.

## SOCIETY CALENDAR

NATIONAL SAFETY COUNCIL, annual congress, Louisville, Ky., October 14-18.

PUBLIC WORKS ENGINEERING CONFERENCE, joint meeting of the American Society of Municipal Engineers and International Association of Public Works Officials, Cincinnati, Ohio, October 14-16.

INSTITUTE OF TRAFFIC ENGINEERS, sixth annual meeting at Louisville, Ky., October 15-16.

AMERICAN SOCIETY OF CIVIL ENGINEERS, fall meeting, Birmingham, Ala., October 16-18.

AMERICAN INSTITUTE OF STEEL CONSTRUCTION, White Sulphur Springs, W. Va., October 16-18.

CANADIAN INSTITUTE OF SEWAGE AND SANITATION, annual convention, Toronto, Ont., October 17-18.

NATIONAL SOCIETY OF PROFESSIONAL ENGINEERS, first annual convention, Columbus, Ohio, October 23-25.

NATIONAL COUNCIL OF STATE BOARDS OF ENGINEERING EXAMINERS, annual meeting, Columbus, Ohio, October 23-25.

AMERICAN ASSOCIATION OF STATE HIGHWAY OFFICIALS, annual convention, Miami, Fla., December 9-12.

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NEW YORK SECTION AMERICAN WATER WORKS ASSOCIATION annual fall meeting, Rochester, N. Y., October 17-18.

WISCONSIN SECTION AMERICAN WATERWORKS ASSOCIATION, annual meeting, Sheboygan, Wis., November 4-6.

VIRGINIA SECTION AMERICAN WATER WORKS ASSOCIATION and VIRGINIA SEWAGE ASSOCIATION, annual conference, Roanoke, Va., November 7-8.

EXPOSITION OF CHEMICAL INDUSTRIES, fifteenth annual exposition, New York City, December 2-7. Metals and alloys, plastics and plant equipment will be included among the exhibits.

NATIONAL SOCIETY OF PROFESSIONAL ENGINEERS announces the organization of the DISTRICT OF COLUMBIA SOCIETY OF PROFESSIONAL ENGINEERS. Officers are: JOHN W. DUNHAM, president; JOSEPH BARNETT, vice-president; STANLEY W. MOULDING, SR., secretary; MILTON KELLERT, treasurer.

## *Personals*

CHARLES A. PETERS, JR., has been named as acting assistant director in charge of buildings in Washington, D. C., which are under the jurisdiction of the National Park Service. Mr. Peters, who graduated in civil engineering from the University of Michigan in 1917, has recently been chief engineer of building for the Service.

H. H. BUSH, previously with the New York State Division of Highways and on the construction of the Grand Central and Northern State Parkways, has now become project superintendent in the Allegheny National Forest.

V. GILLMORE IDEN, who has been acting secretary of the American Institute of Steel Construction, has been elected to the office of secretary. Mr. Iden joined the staff of the American Institute of Steel Construction in 1927 to become its director of public relations.

ARTHUR W. DEAN, chief engineer of the Massachusetts Department of Public Works, resigned that position on Oct. 4 to accept a position as chief engineer of the Massachusetts Planning Board. Mr. Dean graduated from Massachusetts Institute of Technology in 1892 and in 1895 became city engineer of Nashua, N. H., which position he held until 1922 when he became chief engineer for the New Hampshire Traction Co. In 1904 he was appointed state engineer of New Hampshire and in 1909 became chief engineer of the Massachusetts Highway Commission. When that commission was included in the Department of Public Works in 1919 he continued as chief engineer of the division of highways, and in 1929 he became chief engineer of the Department of Public Works.

# Obituary

STUART CAMERON, contractor, died recently at his home in West Vancouver, B. C. He was 62 years of age. Mr. Cameron was president of Stuart Cameron & Co., and vice-president of Armstrong-Morrison & Co.

WILLIAM A. AIKEN, who in recent years served as engineer on sewer work in Westchester County, N. Y., died at his home in Mamaroneck, on Oct. 5, at the age of 84. Mr. Aiken, who was born in Baltimore, graduated in engineering from Rensselaer Polytechnic Institute, and later served under the late William Barclay Parsons, in building the first New York subway. In later years he became a concrete technician on construction work.

EDWIN JOB PICKWICK, an engineer associated with the New York State Power Authority, died at his home in Yonkers, N. Y., on Oct. 7. Mr. Pickwick, who was 60 years old at the time of his death, was born in Bath, England, and later moved to this country. He graduated from Worcester Polytechnic Institute with a civil engineer's degree in 1900. He served for a time as engineer in the construction of the water supply system of the Boston Metropolitan district and later became resident engineer for the New York State Barge Canal. He afterwards became vice-president and general manager of the Alco Construction Co., Utica, N. Y., and was also associated with the Electric Bond & Share Co. as engineer in charge of design and construction of power projects. He joined the State Power Authority in 1933.

# CONSTRUCTION STATISTICS FOR THE WEEK

HEAVY PRIVATE awards push the engineering construction total up to the third highest weekly volume this year, $44,700,000. This brings the cumulative total to date to $1,090,392,000 which, for the first time this year, is higher than the corresponding total a year ago. The corresponding value last year was $1,077,217,000. These totals are made up of: total, $44,700,000 compared with $17,333,000 last year; private, $19,395,000 compared with $1,117,000; public, $25,305,000 compared with $16,216,000; federal, $6,234,000 compared with $1,568,000 and state and municipal, $19,071,000 compared with 14,648,000 a year ago.

Industrial and commercial buildings and unclassified private work are responsible for the high private total while the highest highway awards for any week this year hold up the public total. In round numbers the classification totals are: waterworks, $2,100,000; sewerage, $400,000; bridges, $1,800,000; industrial buildings, $7,600,000; commercial buildings, $4,500,000; public buildings, $4,200,000; earthwork, waterways, etc., $2,900,000; streets and roads, $13,100,000; unclassified, $8,200,000.

The larger awards for the week include: modernizing No. 2 Merchant L mill and 2 new turbo-blowers in blast furnace department, Wisconsin Steel Works, South Chicago, Ill., $2,250,000; electric power plant for Standard Oil Co. refinery, Richmond, Calif., $1,800,000; steel mill for Granite City Steel Co., Granite City, Ill., $2,000,000; first unit (6) of 88 dwellings, separate contracts by Twin Valley Co., Ltd., Ossining, N. Y., $2,000,000; high school, Ogden, Utah, $850,000; highway awards by New York, $841,000 and $1,180,000; by Minnesota, $2,308,000; by Michigan, $678,000; by Iowa, $633,000; by Texas, $1,397,000 and by Long Island City, N. Y., repaving Queens Blvd., day labor (WPA forces), $1,500,000; bridges by Iowa, $496,000; 237-mi. transmission line from Boulder Dam to aqueduct pumping plants and construction of steel towers (2 contracts) by Los Angeles Metropolitan Water Dist., Calif., $810,000; also electrical conductor connectors, clamps, dampers, etc., for above, (2 contracts), $652,000; Lock 25, Mississippi River. Cap au Gris, Mo., $2,121,000, and rural electrification (owner builds) by Buffalo-Niagara-Hudson Co., Buffalo, N. Y., $7,000,000.

State and municipal bond sales for the week total $10,415,000 with a heavy backlog of bonds voted and bond offerings. Federal allotments are beginning to taper off. The total volume of new capital recorded to date, however, is $2,334,268,000 compared with $1,159,067,000 at this time last year. The construction volume curve has turned upward in response to financing.

**CONTRACTS**

(Thousands of Dollars)

| | Weekly Average Oct. 1934 | Prev. 4 Weeks | Week Oct. 10 1935 |
|---|---|---|---|
| Federal Government | $3,034 | $7,214 | $6,234 |
| State and municipal | 15,844 | 16,502 | 19,071 |
| Total public | $18,878 | $23,716 | $25,305 |
| Total private | 3,747 | 5,316 | 19,395 |
| Week's total | $22,625 | $29,032 | $44,700 |
| Cumulative to date: 1934 | $1,077,217,000 | 1935 | $1,090,391,000 |

**NEW PRODUCTIVE CAPITAL**

(Thousands of Dollars)

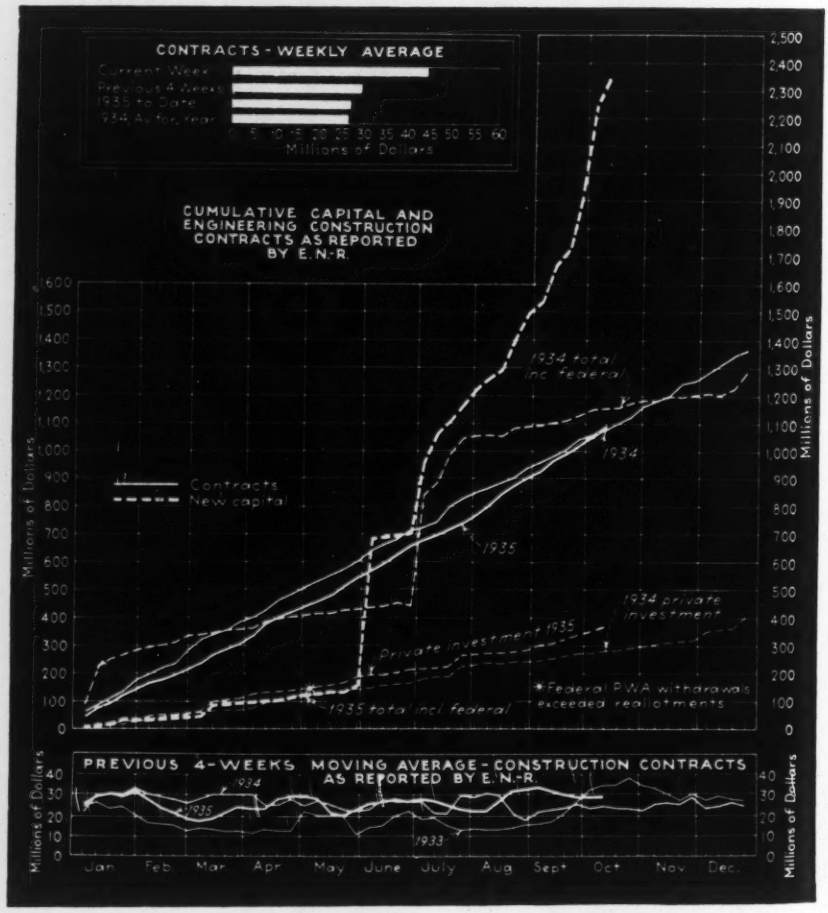
| 1935 | Week Oct. 10 | Cumulative |
|---|---|---|
| State and municipal | $10,415* | $322,180 |
| PWA allotments, S&M. | 8,321* | 757,137 |
| RFC loans, S&M | .... | 48,180 |
| Corporate issues | 3,963 | 27,338 |
| PWA private | .... | 8,629 |
| Local contrib. to WPA. | 625 | 23,967 |
| Total non-federal | $23,324 | $1,197,421 |
| PWA federal | 28,862 | 1,136,847 |
| Total new capital | $52,186 | $2,334,268 |
| Cumulative to date: 1934 | $1,159,067,000 | 1935 | $2,334,278,000 |

*Includes transfer from PWA to public investment through sale by RFC of PWA bonds.

Note: These figures include private bonds, and stocks sold for productive purposes; state and municipal bonds for construction; PWA loans and grants to states and municipalities, including the special highway funds; PWA private loans, and allotments for federal construction, deficiency act funds. An arbitrary percentage (25%) of the WPA allotments and local contributions to WPA work is included to allow for the capital additions through the Works Progress Administration division of the new program.

**INDEX NUMBER**

| ENR Cost | 1913 = 100 | 1926 = 100 | ENR Volume | 1913 = 100 | 1926 = 100 |
|---|---|---|---|---|---|
| **Oct., 1935** | **195.10** | **93.82** | **Sept., 1935** | **127** | **56** |
| Sept., 1935 | 195.10 | 93.82 | Aug., 1935 | 140 | 61 |
| Oct., 1934 | 200.86 | 95.55 | Sept., 1934 | 94 | 42 |
| 1934 (Av.) | 198.10 | 95.23 | 1934 (Av.) | 114 | 50 |
| 1933 (Av.) | 170.18 | 81.80 | 1933 (Av.) | 102 | 47 |
| 1932 (Av.) | 156.97 | 75.45 | 1932 (Av.) | 127 | 56 |



# Current Construction Unit Prices

## Clear Water Creek Water Project, Ft. Smith

CONSTRUCTION of a new $1,500,000 water supply system for Ft. Smith, Ark., started June, 1935, with contracts awarded for clearing of site for a lake and the construction of a combination earth and rockfill dam across Clear Creek, 2 miles north of Mountainburg, together with appurtenant works, two reinforced concrete bridges, 120 ft. and 280 ft. long, and approximately 2 miles of gravel road; the construction of a 6,000,000-gal. filter plant, with operators' houses and clear well storage reservoir; and the construction of 22 miles of 27 in. welded steel pipe line and 3 miles of 12-in. to 24-in. cast-iron pipe line from the dam to the filter plant and from the filter plant to a connection with the distribution system of the city.

Alternate bids were asked for on 67,800 lin.ft. of the 27-in. pipe line for welded steel, cast iron, and reinforced concrete sections; the first type being selected. The welded steel pipe, comprising over half of the total cost of the entire project, is to be laid in 40-ft. lengths, constructed of $\frac{7}{8}$-in. plate, with both inside and outside surfaces coated with bitumastic enamel. The reinforced concrete pipe alternative, costing 10 per cent less than the welded steel, specified continuous welded 16-ga. steel cylinders, with bell and spigot joints fitted with rubber gaskets, completely encased in concrete and reinforced with an outer cage or spiraled wire; pipe sections to be of 12 ft. uniform lengths, total concrete thickness of $3\frac{1}{2}$ in. with not less than $1\frac{1}{8}$-in. concrete lining. W. R. Holway is consulting engineer in charge.

LOW BIDDERS, FT. SMITH WATERWORKS

| | |
|---|---|
| I—Dam Road, Filter Plant Construction | |
| A—M. E. Gillioz, Monett, Mo. (contract) | $543,195 |
| B—Hill & Evans, Ft. Smith, Ark. | 551,595 |
| C—Russ-Mitchell Inc., Houston, Tex | 555,160 |
| II—Steel Pipe Line (Other than Sta. 165 to Sta. 650) | |
| D—Williams Bros., Tulsa, Okla. (contract) | $419,777 |
| E—Stiers Bros. Const. Co., St. Louis, Mo. | 438,199 |
| F—Lock Joint Pipe Co., Ampere, N. J. *(Reinforced concrete pipe comparison) | *382,945 |
| III—Steel Pipe Line (Sta. 165 to Sta. 650) | |
| G—Williams Bros., Tulsa, Okla. (contract) | $326,449 |
| H—Stiers Bros. Const. Co., St. Louis, Mo. | 347,053 |
| K—Forcum-James Co., Dyersburg, Tenn. | 365,750 |
| IV—12 in. to 24 in. C. I. Pipe Lines | |
| L—V & M Const. Co., Oklahoma City, Okla. | $110,137 |
| M—Dobson & Humphreys, Omaha, Neb. | 114,132 |
| N—Ulen Contracting Co., Chicago, Ill. | 116,365 |

UNIT PRICES, FT. SMITH WATERWORKS

| | A | B | C |
|---|---|---|---|
| **Dam & Bridge Construction** | | | |
| 1. Clear and grub—lump sum | $12,000.00 | $9,400.00 | $19,500.00 |
| 2. Earth embankment and rock fill—1,000,000 cu.yd. | .22 | .2375 | .225 |
| 3. Rock excavation—40,000 cu.yd. | .65 | .75 | .45 |
| 4. Shale excavation—35,000 cu.yd. | .20 | .10 | .18 |
| 5. Rock and shale exc. in trench—1,500 cu.yd. | 5.00 | 3.00 | 3.78 |
| 6. Rock riprap, class A—40,000 sq.yd. | .25 | .15 | .45 |
| 7. Rock riprap, class B—1,000 cu.yd. | 4.00 | 4.00 | 1.75 |
| 8. Concrete, class A—550 cu.yd. | 16.00 | 16.00 | 17.70 |
| 9. Concrete, class B—2,125 cu.yd. | 14.00 | 14.00 | 12.50 |
| 10. Concrete, class C—200 cu.yd. | 15.00 | 14.00 | 10.50 |
| 11. Steel reinforcements—250,000 cu.yd. | .04 | .04 | .045 |
| 12. Intake tower accessories—lump sum | 8,000.00 | 6,500.00 | 7,150.00 |
| 13. Slope protection—lump sum | 1,000.00 | 1,000.00 | 750,000.00 |
| **Road Construction** | | | |
| 14. Excavation, unclassified—30,000 cu.yd. | .20 | .30 | .35 |
| 15. Rock excavation—10,000 cu.yd. | .90 | 1.00 | 1.00 |
| 16. Gravel topping—18,000 cu.yd. | 1.75 | 1.50 | 2.70 |
| 17. Culvert, 36 in.—100 lin.ft. | 4.50 | 5.50 | 4.50 |
| 18. Culvert, 30 in.—200 lin.ft. | 4.00 | 4.50 | 3.30 |
| 19. Culvert, 24 in.—450 lin.ft. | 2.50 | 3.10 | 2.75 |
| **Filter plant construction** | | | |
| 20. Excavation, unclassified—14,000 cu.yd. | .50 | .50 | .40 |
| 21. Solid rock excavation—1,000 cu.yd. | 2.00 | 2.00 | 1.50 |
| 22. Solid rock excavation, trench—100 cu.yd. | 3.00 | 4.00 | 4.00 |
| 23. Concrete, class A, filtered water reservoir—565 cu.yd. | 18.00 | 17.00 | 19.50 |
| 24. Concrete, class A, other structures—675 cu.yd. | 18.00 | 17.00 | 18.50 |
| 25. Concrete, class B—1,600 cu.yd. | 18.00 | 14.50 | 13.50 |
| 26. Concrete, class C—100 cu.yd. | 14.00 | 13.50 | 10.50 |
| 27. Steel reinforcement—370,000 lb. | .04 | .04 | .04 |
| 28. Filter bldg., headhouse, gateway—lump sum | 21,000.00 | 16,500.00 | 24,500.00 |
| 29. Operator's residence—lump sum | 8,000.00 | 9,000.00 | 7,650.00 |
| 30. Stone masonry, settling basins—lump sum | 1,000.00 | 1,100.00 | 775.00 |
| 31. Stone masonry, retaining walls—200 cu.yd. | 10.00 | 15.50 | 9.70 |
| 32. Electrical work—lump sum | 5,500.00 | 6,500.00 | 5,685.00 |
| 33. Filter equipment, inside piping, valves—lump sum | 31,000.00 | 32,000.00 | 32,960.00 |
| 34. Chemical feed equipment—lump sum | 5,000.00 | 4,700.00 | 5,590.00 |
| 35. Mechanical mixing equipment—lump sum | 3,700.00 | 4,500.00 | 3,795.00 |
| 36. Hydraulic turbine generator set—lump sum | 4,500.00 | 5,300.00 | 4,400.00 |
| 37. Oil engine generator set—lump sum | 4,000.00 | 4,700.00 | 3,850.00 |
| 38. Heating plant—lump sum | 1,300.00 | 1,450.00 | 1,275.00 |
| 39. Outside piping & valves—lump sum | 9,000.00 | 12,500.00 | 11,130.00 |
| 40. Miscellaneous—lump sum | 3,000.00 | 2,100.00 | 1,830.00 |
| **II—27 in. Pipe Line (with alternatives)** (To Sta. 165, and from Sta. 650 to Sta. 1190) | D | E | F |
| 41. Cast iron pipe, 27 in.—67,800 lin.ft. | | | |
| 42. Welded steel pipe, 27 in.—67,800 lin.ft. | 5.58 | 5.83 | |
| 43. Reinforced concrete cyl. pipe, 27 in.—67,800 lin.ft. | | | 5.00 |
| 44. Rock excavation, extra—3,000 cu.yd. | 4.00 | 3.00 | 2.50 |
| 45. Concrete, class C—200 cu.yd. | 10.00 | 14.50 | 12.00 |
| 46. Arkansas River crossing—27 in. alternative—lump sum | 20,000.00 | 23,425.00 | 27,000.00 |
| 47. Arkansas River crossing—double 18 in. alternative—lump sum | 36,245.00 | 33,000.00 | 39,000.00 |
| 48. Valves, air valves, blow offs, vaults—lump sum | 4,987.00 | 4,300.00 | 4,200.00 |
| 49. Paving cuts and repairs—200 lin.ft. | 1.00 | 1.00 | 1.60 |
| 50. Van Buren Water System connection—lump sum | 1,746.00 | 2,600.00 | 1,875.00 |
| 51. Connections, 2in—20, each | 26.00 | 25.00 | 32.50 |
| **III—27 in. Steel pipe line** (Sta. 165 to Sta. 650) | G | H | K |
| 52. Welded steel pipe, 27 in. & fittings—48,500 lin.ft. | 5.58 | 5.93 | 5.90 |
| 53. Rock excavation—12,000 cu.yd. | 1.50 | 2.50 | 4.00 |
| 54. Concrete, class C—900 cu.yd. | 10.00 | 15.00 | 12.00 |
| 55. Creek crossings—lump sum | 15,000.00 | 1,200.000 | 3,000.00 |
| 56. Railroad crossings—lump sum | 2,500.00 | 3,080.00 | 900.00 |
| 57. Culverts, 36 in.—400 lin.ft. | 5.00 | 5.17 | 12.00 |
| 58. Valves, air valves, blow offs and vaults—lump sum | 7,859.00 | 8,100.00 | 10,000.00 |
| 59. Connections, 2in.—20, each | 26.00 | 25.00 | 30.00 |
| 60. Structural steel, pipe anchorage—10,000 lb. | .094 | .10 | .15 |
| **IV—12, 16, 20, 24 in. C.I. pipe lines** | L | M | N |
| 61. Cast iron pipe, etc. 24 in.—9,300 lin.ft. | 6.75 | 6.98 | 7.10 |
| 62. Cast iron pipe etc. 20 in.—2,700 lin.ft. | 5.19 | 5.51 | 6.20 |
| 63. Cast iron pipe, etc. 16 in.—3,800 lin.ft. | 3.84 | 4.07 | 4.70 |
| 64. Cast iron pipe, etc. 12 in.—350 lin.ft. | 2.60 | 2.93 | 3.50 |
| 65. Cast iron bell and spigot specials—20,000 lb. | .07 | .065 | .09 |
| 66. Rock excavation, extra—100 cu.yd. | 4.00 | 2.00 | 1.50 |
| 67. Gate valves—lump sum | 1,775.00 | 400.00 | 1,250.00 |
| 68. Pavement, cut and repair—2,000 lin.ft. | 1.00 | 1.25 | .60 |
| 69. Sidewalk removed and replaced—1,500 lin.ft. | .50 | .80 | .40 |
| 70. Concrete curb removed and replaced—300 lin.ft. | 1.00 | 1.00 | .30 |
| 71. Connections—lump sum | 800.00 | 550.00 | 600.00 |
| 72. Concrete, class C—100 cu.yd. | 15.00 | 12.00 | 10.00 |
| 73. Control valves and vault—lump sum | 6,422.00 | 8,000.00 | 5,700.00 |
| 74. Fire hydrants—20, each | 125.00 | 110.00 | 106.00 |

## Alcova Diversion Dam, Wyoming

BIDS were received July 15 and contract was awarded Aug. 29, 1935, for the construction of a 900-ft. earth dam, 180 ft. in height above the river bed, across the North Platte River at Alcova, Wyo. A diversion tunnel has been completed under a previous contract. Unusual features of construction are the grout curtains required, formed of holes to be drilled 5 ft. and 10 ft. apart to a maximum depth of 250 ft. under the upstream and downstream cutoff walls, at the ends of the spillway, and throughout the entire bed of the river upstream from the axis of the dam, to extend into the underlying limestone formation. Drainage is provided by a gallery beneath the dam extending under both abutments. Work is scheduled for completion 930 days after contract award with PWA minimum wage rates prevailing of $1.20 per hr. for skilled and 50c. per hr for common labor. The government furnishes f.o.b. Casper, all cement, admixtures, except sand for grout, reinforcing bars, misc. iron and metal work, sewer pipe, and in general all materials other than sand, stone, or gravel or those materials required in the process of construction but not

actually a part of the completed construction. Sand and gravel are available gratis for the contractors, from natural deposits located 4,000 ft. downstream from the dam site.

The following tabulations list the unit prices and totals of the three low bidders. The project is under the jurisdiction of the Bureau of Reclamation, H. W. Bashore, construction engineer. (A) W. E. Callahan Const. Co., Dallas, Texas. Gunther & Shirley, Los Angeles, Cal. (contract) $1,482,651; (B) Martin Wunderlich Co., Jefferson City, Mo., $1,523,083; (C) Winston Bros Co., Minneapolis Minn., $1,555,712.

ALCOVA DIVERSION DAM, WYOMING

| Item | A | B | C |
|---|---|---|---|
| 1. Diversion and care of river during construction—total | $28,000.00 | $20,000.00 | $55,000.00 |
| 2. Excavation, strip sand & gravel—5,000 cu.yd | .30 | .16 | .20 |
| 3. Excavation, strip borrows pits—52,500 cu.yd | .25 | .16 | .20 |
| 4. Excavation, common, strip embankment—127,000 cu.yd | .25 | .60 | .50 |
| 5. Excavation, rock, strip embankment—200 cu.yd | 7.00 | 5.00 | 5.00 |
| 6. Excavation, common embankment foe drains—200 cu.yd | 2.00 | 3.00 | 1.50 |
| 7. Excavation, rock, embankment foe drains—350 cu.yd | 3.50 | 4.00 | 3.00 |
| 8. Excavation, rock, open trench, cut off wall ftgs.—500 cu.yd | 10.00 | 8.00 | 5.00 |
| 9. Excavation, rock, open cut, drainage gallery—250 cu.yd | 5.00 | 4.00 | 5.00 |
| 10. Excavation, misc. drainage, shafts, stopes—1,720 cu.yd | 9.00 | 20.00 | 16.00 |
| 11. Excavation, rock, trash rack struct.—45 cu yd | 10.00 | 10.00 | 6.00 |
| 12. Excavation, common, spillway—17,500 cu.yd | .27 | .30 | .40 |
| 13. Excavation, rock, spillway—281,000 cu.yd | .81 | 1.00 | .85 |
| 14. Excavation, misc., outlet works operating house—40 cu.yd | 4.00 | 3.00 | 6.00 |
| 15. Excavation, common, borrow pits & transp. to dam—1,103,700 cu.yd | .26 | .30 | .28 |
| 16. Excavation, rock, borrow pits & transp. to dam—63,000 cu.yd | .70 | 1.10 | .80 |
| 17. Backfill—1,500 cu.yd | .70 | 1.00 | 1.00 |
| 18. Gravel fill under floors—20 cu.yd | 2.00 | 2.00 | 3.00 |
| 19. Riprap, spillway outlet—1,500 cu.yd | 1.50 | 1.50 | 2.00 |
| 20. Earth fill, embankment—935,300 cu.yd | .08 | .08 | .07 |
| 21. Sand, gravel, cobble fill, embankment—127,000 cu.yd | .07 | .25 | .14 |
| 22. Rock fill, downstream embankment—388,000 cu.yd | .10 | .20 | .17 |
| 23. Riprap, upstream embankment—61,000 cu.yd | .45 | .30 | .40 |
| 24. Gravel fill, trash rack struct.—275 cu.yd | 2.50 | 2.00 | 3.00 |
| 25. Drill A grout holes to 50 ft.—1,000 lin.ft | 2.60 | .90 | 1.40 |
| 26. Drill A grout holes to 100 ft.—2,800 lin.ft | 2.60 | 1.20 | 1.60 |
| 27. Drill A grout holes to 150 ft.—3,200 lin.ft | 2.60 | 1.30 | 1.80 |
| 28. Drill B grout holes to 25 ft.—3,700 lin.ft | 2.00 | .80 | 1.00 |
| 29. Drill B grout holes to 50 ft.—2,800 lin.ft | 2.00 | .90 | 1.15 |
| 30. Drill B grout holes to 100 ft.—34,000 lin.ft | 2.00 | 1.10 | 1.25 |
| 31. Drill B grout holes to 150 ft.—2,000 lin.ft | 2.00 | 1.20 | 2.00 |
| 32. Drill B grout holes to 250 ft.—1,600 lin.ft | 2.00 | 1.50 | 2.50 |
| 33 Wash bore & case holes, fdt. grouting—10,000 lin.ft | 2.00 | 2.00 | 2.00 |
| 34. Instal. grout pipe & fittings—16,000 lb | .20 | .08 | .10 |
| 35. Pressure grouting—150,000 cu.ft | .55 | .40 | .65 |
| 36. Drill drainage holes to 50 ft.—2,800 lin.ft | 2.50 | 1.00 | 2.00 |
| 37 Weep holes—100 lin.ft | .90 | .50 | 1.00 |
| 38. Drill holes, anchor & grouting bars—3,700 lin.ft | 1.00 | .50 | .75 |
| 39. Construct 15-in. dia. clay pipe drains 1,300 lin.ft | .50 | 1.50 | 1.00 |
| 40 Construct 12-in. dia. clay pipe drains—400 lin.ft | .40 | 1.00 | 1.00 |
| 41. Construct 8-in. dia. clay pipe drains—200 lin.ft | .30 | 1.50 | 1.00 |
| 42. Construct 6-in. dia. clay pipe drains 1,250 lin.ft | .30 | 1.25 | .80 |
| 43. Construct 4-in. dia. clay pipe drains—3,000 lin.ft | .30 | 1.00 | .60 |
| 44. Porous concrete under spillway gate—50 cu.yd | 7.00 | 10.00 | 10.00 |
| 45. Concrete cutoff walls, open trenches—1,460 cu.yd | 15.00 | 12.00 | 13.50 |
| 46. Concrete cutoff walls, stoped exc.—320 cu.yd | 8.00 | 7.00 | 9.00 |
| 47. Concrete, drainage gallery—275 cu.yd | 11.00 | 11.00 | 12.50 |
| 48. Concrete, drainage tunnels, shaft—730 cu.yd | 16.00 | 12.00 | 15.00 |
| 49. Concrete, gate chamber, tunnel plug—920 cu.yd | 16.00 | 20.00 | 12.00 |
| 50. Concrete, trash rack struct.—300 cu.yd | 20.00 | 15.00 | 17.50 |
| 51. Concrete, outlet works operating house—330 cu.yd | 20.00 | 14.00 | 26.50 |
| 52. Concrete, parapet, curbs, sidewalk—500 cu.yd | 16.00 | 16.00 | 18.00 |
| 53. Concrete, spillway lining—8,860 cu.yd | 8.00 | 8.00 | 9.00 |
| 54. Concrete, spillway struct. to El. 5,536.5—10,970 cu.yd | 16.00 | 11.00 | 13.75 |
| 55. Concrete, spillway superstructure—300 cu.yd | 20.00 | 30.00 | 26.00 |
| 56. Surfacing concrete, special—6,000 sq.yd | .60 | .40 | .70 |
| 57. Place reinforcing bars—2,200,000 lb | .02 | .013 | .017 |
| 58. Install bonded cement floor & base—82 sq.yd | 1.00 | 2.00 | 1.50 |
| 59. Install corkboard, contraction joints—130 sq.ft | .30 | 1.00 | .30 |
| 60. Install asphalt felt roofing, flashings—533 sq.ft | .20 | .40 | .50 |
| 61. Install spillway gates, frames, etc.—504,000 lb | .02 | .013 | .0225 |
| 62. Install spillway gate hoists & operators—225,000 lb | .03 | .016 | .03 |
| 63. Install trash rack metal work—165,000 lb | .02 | .015 | .02 |
| 64. Install h.p. hydraulic operated gates, conduits—346,000 lb | .04 | .015 | .025 |
| 65. Install h.p. gate controllers—5,300 lb | .15 | .10 | .10 |
| 66. Install internal differential needle valves—368,400 lb | .04 | .015 | .025 |
| 67. Install cranes, hoists, pumps, blowers—55,000 lb | .04 | .02 | .025 |
| 68. Install stairways, walkways—33,500 lb | .04 | .02 | .06 |
| 69. Install metal tubing, std. pipe, etc.—32,600 lb | .10 | .03 | .10 |
| 70. Install galv. metal air piping—7,000 lb | .10 | .08 | .10 |
| 71. Install metal water stops—1,400 lin.ft | .40 | .30 | .30 |
| 72. Install metal doors—405 sq.ft | .40 | .30 | .80 |
| 73. Install metal sash, louvers—504 sq.ft | .50 | .50 | .50 |
| 74. Install misc. metal work—35,000 lb | .15 | .10 | .08 |
| 75. Install 1½ in. & less metal conduit—2,000 lin.ft | .20 | .08 | .20 |
| 76. Install over 1½ in. dia. metal conduit—1,500 lin.ft | .30 | .10 | .25 |
| 77. Install electrical fibre conduit—3,000 lin.ft | .25 | .08 | .25 |
| 78. Install electrical conductors—total | 600.00 | 300.00 | 1,000.00 |

## Steel Railroad Bridges, Muskingum Valley

ELEVEN steel railroad bridge superstructures, foundations for which were included in the railroad realignment construction contracts now under way in the Muskingum Valley, Ohio, flood control district, were awarded in August, 1935 to the Mt. Vernon Bridge Co. The work includes the furnishing and erection of 2,400 tons of structural steel, 269 M f.b.m. creosoted oak timber decking and 2,215 lin. ft. of wrought iron handrail. No bidder was consistently low on all bridges, four proposals being numbered among the three low unit prices for the eleven different locations, but contract was awarded to the lowest bidder on the eleven structures combined. The unit prices and totals of these four bidders follow. (A) Mt. Vernon Bridge Co., Mt. Vernon, O. (contract) $245,505; (B) Ft. Pitt Bridge Works $263,207; (C) McClintic-Marshall Corp., Bethlehem, Pa. $268,555; (D) American Bridge Co., Pittsburgh, Pa. $272,188.

STEEL BRIDGES, MUSKINGUM VALLEY RAILROAD RELOCATIONS

| Location | Structural steel, Quan. lb. | A | B | C | D | Creosoted oak timber, Quan. M.B.M. | A | B | C | D |
|---|---|---|---|---|---|---|---|---|---|---|
| 1. Pennsylvania R.R.—Wills Creek—Wills Creek Reservoir | 455,000 | $.0442 | $.05 | $.047 | $.0492 | 25 | $89.00 | $84.00 | $103.00 | $99.00 |
| 2. Pennsylvania R.R.—Conotton Creek—Dover Reservoir | 550,000 | .046 | .0535 | .0477 | .0478 | 30 | 86.00 | 85.00 | 106.00 | 96.00 |
| 3. Wheeling & Lake Erie R.R.—stream at New Cumberland—Dover Reservoir | 275,000 | .045 | .0519 | .05 | .0494 | 20 | 86.50 | 83.00 | 100.00 | 95.50 |
| 4. Wheeling & Lake Erie R.R.—Conotton Creek—Dover Reservoir | 411,000 | .0465 | .05 | .047 | .0473 | 26 | 87.50 | 84.00 | 100.00 | 96.00 |
| 5. Wheeling & Lake Erie R.R.—Tuscarawas River—Dover Reservoir | 532,000 | .0432 | .0467 | .0462 | .0473 | 32 | 85.50 | 85.00 | 102.00 | 95.50 |
| 6. Baltimore & Ohio R.R.—Sandy Creek—Bolivar Reservoir | 476,000 | .0466 | .0464 | .0485 | .0503 | 28 | 88.00 | 86.00 | 108.00 | 96.00 |
| 7. Baltimore & Ohio R.R.—Sugar Creek—Beach City Reservoir | 347,000 | .044 | .0494 | .05 | .049 | 22 | 89.50 | 78.00 | 106.00 | 96.50 |
| 8. Wheeling & Lake Erie R.R.—Sugar Creek—Beach City Reservoir | 316,000 | .0456 | .0496 | .0505 | .0535 | 22 | 86.50 | 86.25 | 109.00 | 97.00 |
| 9. Pennsylvania R.R.—Mohican River—Mohawk Reservoir | 584,000 | .0465 | .0467 | .047 | .048 | 30 | 87.50 | 80.00 | 100.00 | 95.50 |
| 10. Erie R.R.—Crawford Creek—Charles Mill Reservoir | 125,000 | .04195 | .0474 | .0447 | .0511 | 12 | 94.00 | 86.00 | 102.00 | 97.00 |
| 11. Erie R.R.—Black Fork—Charles Mill Reservoir | 735,000 | .0499 | .0542 | .055 | .056 | 22 | 92.00 | 86.70 | 100.00 | 97.00 |